The FOUNDRY

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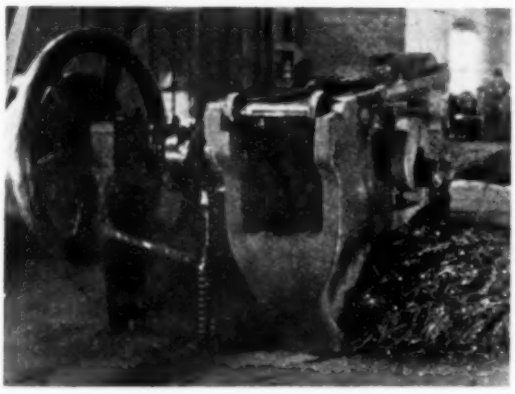
Castings Resist Shock in Nail Making Machines

ORDINARY nails, sold by the keg at a price little higher than the wire from which they are made, are accepted as a matter of course throughout all industry making use of wood. Indeed, in computing the price of a wooden structure, whether it be a packing box or a frame dwelling, the cost of the nails is an insignificant item in comparison with the cost of the whole. However, such a state of affairs did not always exist. Before the beginning of the nineteenth century all nails were made by hand and were the products of laborious cutting and heading on hand forges. In the Birmingham district in England some 60,000 persons were employed in making nails. Their weekly consumption of nail rods from the iron works in the district was 200 tons. Modern nail making machinery can be appreciated more when compared to the methods of those early days. Castings are an essential part in the machines that make modern nails so easily and cheaply. Year in and year out, castings stand up under vibratory attack of tack and spike machines.



Courtesy Colorado Fuel & Iron Co.
Vibration Is Absorbed by Castings in Nail Making Machinery

Find Where Castings Can Be Sold

CONTENTS

FEATURE ARTICLES

	Page
Facilitates Production of Large Steel Castings—By E. C. Kreutzberg	44
Declining Markets Effect Small Changes in Costs	50
Prevent Losses With Proper Gates and Risers—Part VIII—By Pat Dwyer	52
Iron Reduces Crystal Size of Aluminum Bronze—By Charles Vickers	55
Gray Iron Possesses Valuable Engineering Properties	58
Classifies Gray Iron Mixtures	61
Indirect Heat Utilized in Dual Purpose Oven—By J. B. Nealey	70
Canadian Shop Controls Products	73
Bill Hears of Bread Cast Upon Water—By Pat Dwyer	75
Gangway! The Skipper's Daughter Takes the Wheel	78

REGULAR DEPARTMENTS

Reader's Comment	63	The Shakeout	80
Questions and Answers on Foundry Practice	64	Comings and Goings of Foundrymen	81
The Foundry Family Photograph Album	67	Directory of Foundry Associations	82
The Foundry Data Sheet	68	Trade Trends in Tabloid	85
Problems in Nonferrous Founding—By Charles Vickers	69	What the Foundries Are Doing	86
What Others Are Thinking	79	New Trade Publications	86

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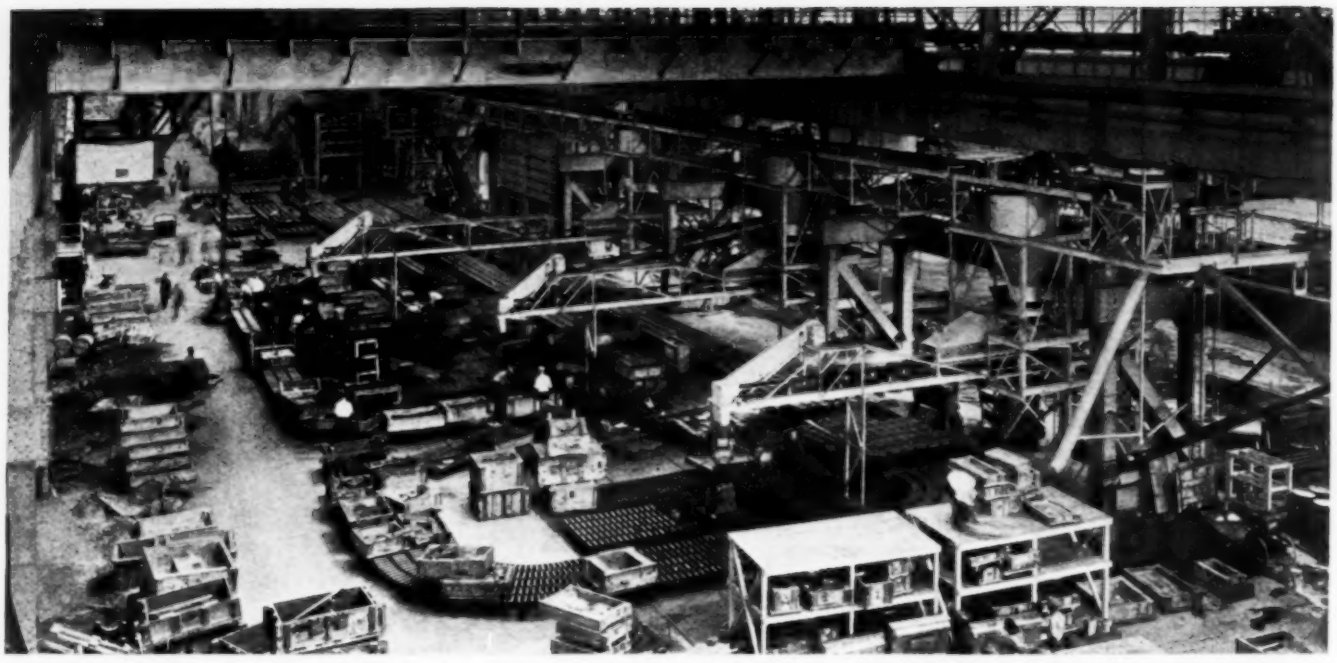


Fig. 1—General View of the Coremaking Department Looking Toward the Continuous Oven

Facilitates Production of

By E. C. Kreutzberg

LARGE STEEL CASTINGS

THE new plant of the General Steel Castings Corp., Eddystone, Pa., provides facilities by which designers and users of large steel castings may rid themselves to a considerable extent of size limitations. Many of the methods in use were developed some years ago at the plant of the Commonwealth Steel Co., Granite City, Ill., now a group member of the General Steel Castings Corp.

Large castings for locomotives and railroad cars are to be the chief product. Locomotive beds now cast in one piece, replace former assemblies of 240 pieces cast separately, machined and then joined by bolting or wedging. One piece locomotive beds, tender frames, gondola bodies freight car sides and other large railroad castings are to be produced in volume. This field is expected to expand continually, not only because one piece steel castings resist corrosion more effectively than jointed, rolled steel bodies, but also because integral castings do not have joints to be tightened and renewed periodically.

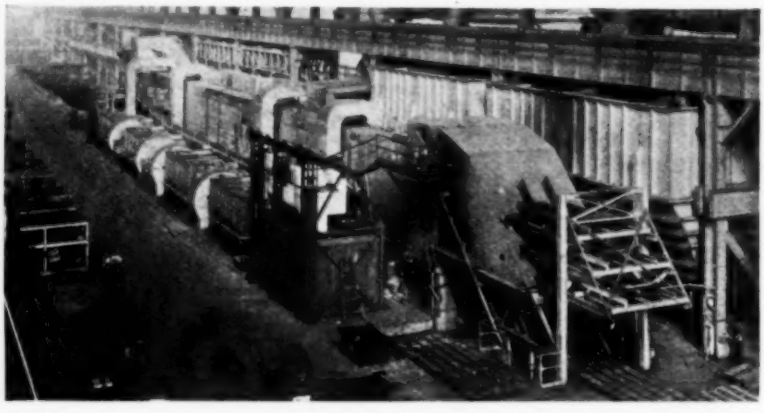


Fig. 2—Roller Conveyors Receive the Cores at the Discharge End of the Oven

One reason for building the plant at Eddystone was the nearness to the great market for railroad equipment. The company is organized to work in close association with car and locomotive builders, with ship builders, marine engineers, the electrical industry, with builders of heavy machinery of all kinds, in brief with all who are connected with or interested in the design and application of large steel castings. To some extent the new plant may be regarded as another competitor in an already highly competitive field, but this feature is offset by the probability that practice

developed here will extend the steel casting field beyond its former limits of possibility.

Anticipated production of large castings for miscellaneous use was another reason for the selection of Eddystone. Analysis of the potential market for large castings showed that the largest are designed for use on or near deep water. Eddystone on the Delaware river just below Philadelphia, is ideally located for loading large castings on ocean going vessels destined for any part of the world.

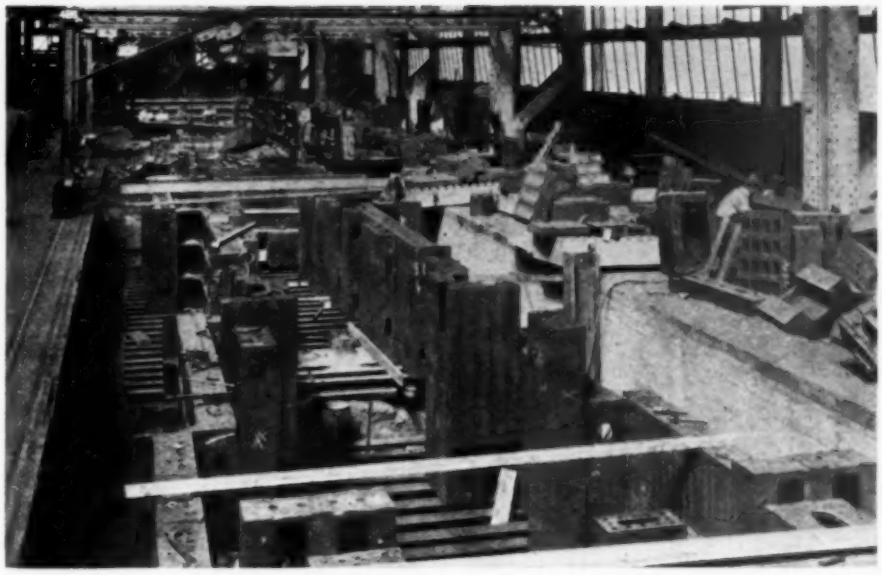


Fig. 4—One of the Locomotive Bed Pits in Course of Construction

Present capacity of the plant is between 6000 and 7000 tons of castings per month. About two-thirds of this capacity is available and sufficient to fill present normal casting requirements of eastern railroads, car and locomotive builders. The remaining capacity is available for general jobbing castings, large and small. Up to the present, castings are produced up to 150 tons in weight.

Principal departments of the plant, foundry, patternshop, pattern storage, machine shop, cleaning department and a maintenance machine shop are on a site bounded on three sides by open water and on the fourth by the tracks of the Pennsylvania and the Philadelphia and Reading railroads. Expense was not spared on the buildings. Instead of the usual 16,000 to 18,000 pounds per square foot allowable load per unit of steel section in the buildings, the company built with 12,000 to 14,000 pounds as the allowable load. Buildings are substantial.

The buildings of steel, brick, concrete and glass construction stand on filled in marsh land and are floored with macadam. This material is resilient and flexible and readily may be repaired and leveled when or if it settles. Space has been allowed alongside each building for two more exactly like it. Eventually the plant may be enlarged to three times present size.

In advance of construction, a complete miniature of the plant was laid out for inspection. This miniature plant was built on a scale of ¼-inch per foot, or 1/48 actual size, and was the subject of continual study and modification for several months. Three basic features continually were kept in view: The product, the equipment needed and the ideal flow of material.

Now that the plant actually is in operation, a master flow chart governs every arrangement. Basic travel of the product from major operation

Fig. 3—Locomotive Frame as It Appears Lifted from the Pit with All the Forming Cores Still in Place. Note the Multiplicity of Risers Over the Entire Upper Surface

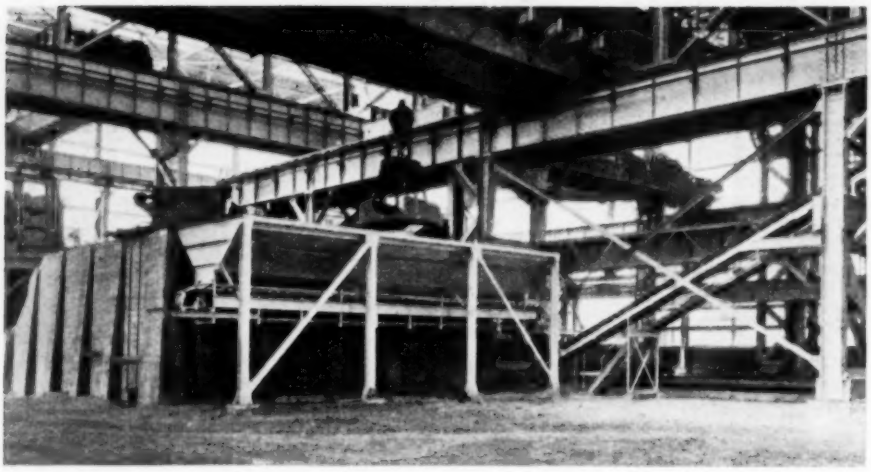


Fig. 5—A Grab Bucket Supplies the Feeder Hopper with New Sand

to major operation, also is the key which governs the flow of all secondary travel. All tributaries flow into main arteries and practically no back tracking or cross travel is noticeable. Patterns travel from the pattern storage into the foundry through a channel that does not conflict with the general scheme. According to a set of traffic rules that has been worked out in practice and adopted, through traffic has the right of way. Way station traffic is handled on a schedule which enables the entire flow system to function without interruption.

Shunt the Cars

Production current begins and ends on classification tracks just inside the company's property. These tracks serve as an elastic cushion for inbound and outbound freight. Railroad authorities can suit their own convenience in moving the cars. Plant shunting is done by the company's own locomotives.

A raw material storage yard about 2000 feet in length, parallels the classification tracks. This yard forms a reserve. To eliminate handling costs as far as possible, the raw materials are used as they arrive. The reserve yard is pressed into service only when incoming shipments do not meet consumption requirements. The yard is served by a 10-ton gantry crane with a 75-foot span and a 25-foot overhang at each end. This crane transfers incoming material to stock piles, or, directly into cars and buggies.

Materials sufficient for the furnace charges are weighed and placed on the *heat storage* tracks during the day. This eliminates furnace delay. One complete furnace charge always is waiting. The open hearth department is self contained so far as switching service is concerned. The loaded cars are hauled up to the charging platform with a wire cable. Empty cars run down an incline from the other end of the charging platform and return by gravity to any desired point under the gantry crane.

Steel is melted in three 50-ton open-hearth furnaces equipped with doors sufficiently large to admit scrap beyond the usual charging box size. This arrangement eliminates considerable cutting expense.

The regenerators below the floor are encased in steel plate to prevent air leakage. So far as possible the furnaces are insulated with 4½ inches of an insulating brick laid against the plates. Special devices maintain correct combustion conditions. Control apparatus for fuel oil and air is located on a stand at the rear of the charging floor. Here also is a large instrument board equipped with pyrometers, draft, oil and steam pressure gages, oil flow meters, etc., for the guidance of the melter. Space beneath the furnaces is utilized for the storage of brick and other maintenance material.

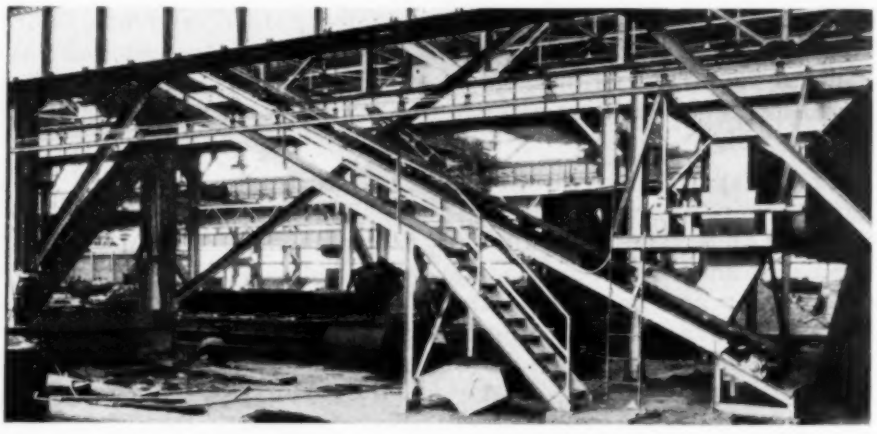


Fig. 7—Sand from the Storage Bins Is Handled by Belt Conveyors

Fig. 6—Old and New Sand Are Fed to the Mills from Overhead Bins

Instead of setting up a plant to function within the limitations of known equipment, the company decided to operate in a certain manner and then presented specifications to manufacturers to provide equipment for this purpose. As a result many pieces of equipment in this plant differ from heretofore existing standards. For example the 60-ton ladles are equipped with two nozzles, set diametrically opposite each other.

The foundry building, 1176 feet in length is divided transversely into three 90-foot bays each 996 feet in

length. The remainder of the space at the north end is occupied by the furnaces and auxiliary equipment including a 75-ton ladle crane which serves all three furnaces. Two of the main foundry bays are devoted to molding activities. Cores are prepared in the third.

Roller conveyors are employed extensively for expediting the flow of material through the foundry. Cranes are installed in such a manner that so far as possible individual loads are handled by cranes of suitable capacity and the anomaly is not presented of a 2-ton load suspended from a 75-ton crane. Rugged construction features all handling equipment designed to operate with minimum time out for repair. For example, the gantry crane in the yard is a full roller bearing machine with the latest type of time control, with one piece trolleys and other departures from usual design. Crane parts throughout the plant are interchangeable. This arrangement reduces the number of spare parts required in stock and speeds up any necessary repairs.

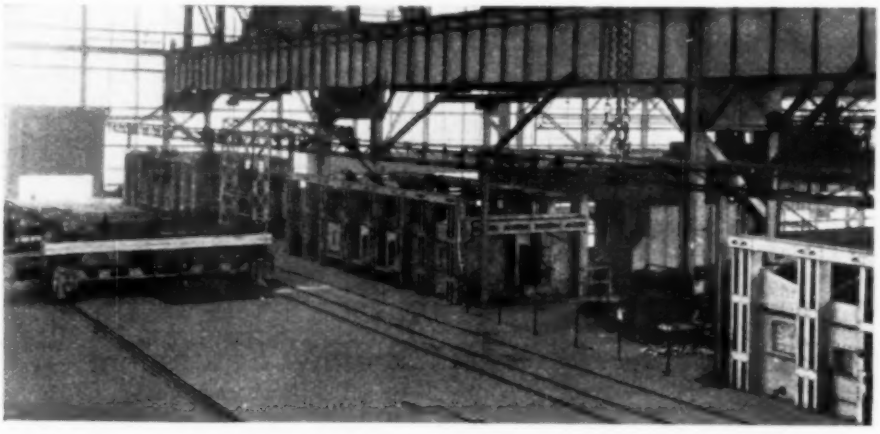


Fig. 8—General View of the Charging Floor of the Three 50-Ton Furnaces

Each of the two molding bays is equipped with two 75-ton and two 40-ton overhead traveling cranes, also four one-leg 10-ton gantry cranes and below these, on a lower runway, a series of one-leg 2-ton gantry cranes. These small cranes are controlled from the floor.

Patterns and coreboxes are handled collectively. Parts for each job are stored in one or in adjoining racks in the pattern storage building, and the entire set of patterns is moved as a unit. For example when the patterns for a locomotive bed—250 pieces — are required in the foundry, a few sectional parts from the pattern storage are transferred bodily. Where changes are necessary, the sections first are taken to the pattern shop. When the job is finished the patterns and coreboxes once more are placed in the racks according to a number and letter system and replaced in the pattern storage building with a lift truck.

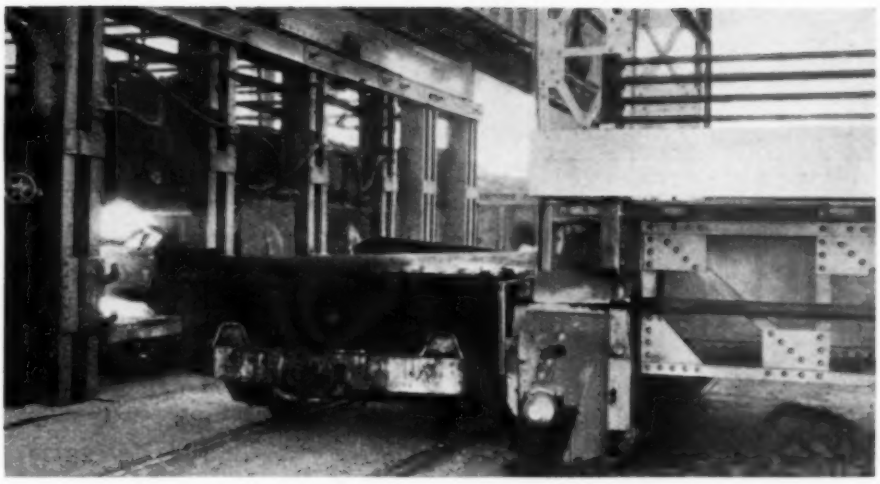


Fig. 9—A Charging Machine Dumps the Various Materials in the Furnace

In ordinary steel foundry core room practice, the necessity is recognized of heating from 5 to 10 pounds of core plate per pound of sand in the core. At Eddystone this proposition has been reduced to a remarkable extent. It is claimed that the proportion is 10 pounds of sand to 1 pound of steel in the plate. This has been accomplished by the adoption of thin steel plates. The thin steel plates in turn are responsible for the manner in which the cores are made and dried. The plates are so thin that the cores cannot be handled in the usual manner while in the green state.

Sand is packed in the coreboxes under sand slinging machines. At this point the core starts on a roller conveyor journey that conveys it eventually to an assembling and sorting station outside the discharge end of a continuous oven. From the ramming station the corebox and core move on rollers to an adjoining station where the surface is scraped flat and one of the thin bottom plates adjusted in place. At the next stopping point the assembly is clamped to the table of a rollover machine and inverted. This machine is equipped with a vibrator and a pattern drawing device which removes the corebox and leaves the core resting on the thin plate which in turn is supported through its length and

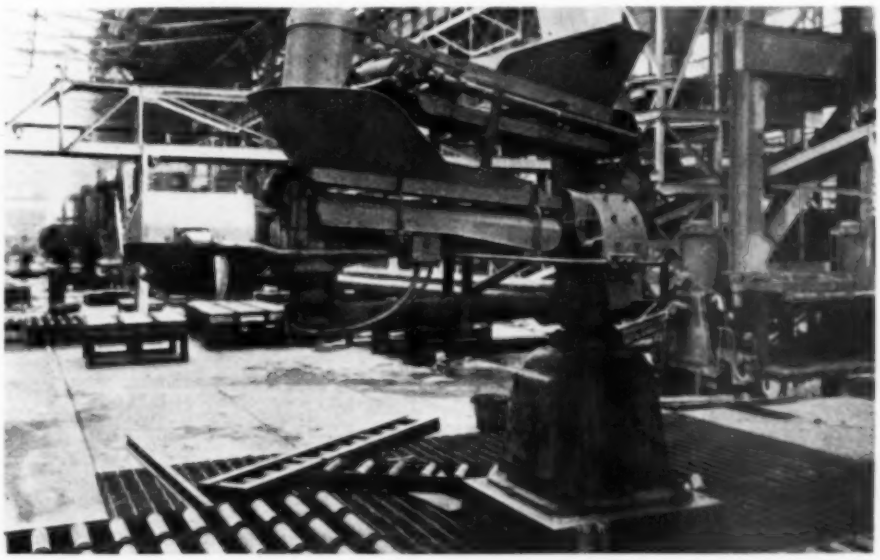


Fig. 10—A Battery of Four Sand Slinging Machines Fills the Coreboxes

Fig. 11—Cores Are Discharged into a Breaker Where Sand and Rods Are Separated

width by the rollers. Four of these machines vary in size. The largest will handle coreboxes up to 6 x 8 feet and 4 feet deep.

The receiving tables of the rollover machines are equipped with roller conveyor units set flush with the floor. From this short section of conveyor the core on its plate enters upon an extension which carries it to the core oven.

The continuous core oven 230 feet in length is arranged in five tiers, each tier traveling at a speed different from the others. The time varies from 1½ to 8 hours depending on the size of the cores. An elevator lifts the cores at the entrance of the oven and locks automatically at any tier level. A piston rod from an air cylinder pushes core and plate into the oven. At the opposite end of the oven the core and plate are pushed out on to an elevator which lowers the load to a conveyor line at floor level. Through variation in speed, the tiers are discharged at varying intervals rather than in set sequence. A system of signal lights guides the operators at both ends of the oven.

Assemble the Cores

At the discharge end of the oven the cores are assorted and assembled in racks and these racks are conveyed on lift trucks to their destination at any point on the molding floors. Procedure in the case of a set of cores for a locomotive bed may be cited as an example. The 500 to 600 individual cores required for this job are loaded on 20 to 30 racks, each carrying from 10 to 30 cores. The racks are placed as near as possible to that part of the mold for which the cores are destined and the cores are picked up and set in place in the mold by the small cranes referred to previously. The cores are loaded on the rack in proper rotation so that in the reverse process they may be removed and placed directly in their proper places in the mold.

Pits in the foundry floor facilitate the prevailing method of molding which is to form the mold in a number of cores assembled in suitable metal casings. The pits vary in dimensions. The smallest is 20 feet in width and the largest is 90 feet square. Others vary in length between 90 and 180 feet. They also vary in depth between 6 and 12 feet. The combined cores for a one piece locomotive bed mold weigh between 100 and 120 tons. With the forms which hold the cores in place, the entire mold weighs between 200 and 300 tons.

A considerable volume of large castings for miscellaneous use are molded in the usual manner in standard type flasks. These molds are dried in a car type, oil fired oven.

The continuous core oven is heated by four oil fired units, each located in an individual combustion chamber. Ventilation to assure correct circulation of air for proper drying conditions is regulated by dampers which force the air through a system of ducts. Conveyor bearings in this oven are nickel-chrome steel and are highly heat resistant.

Cleaning facilities in this plant are on a large scale in keeping with the general character of the product. Thus a locomotive frame or other large casting is lifted from the mold and with most of the cores still clinging in position, is transferred to a point over a hopper in the foundry floor. Giant vibrators, modified types of pile hammers and rock drills, are set in motion with the result that the sand covering of the casting is shaken loose and falls through the hopper on to a pan conveyor which discharges into a revolving drum 12 feet in diameter and 26 feet in length. The sand lumps are broken in this drum and the sand falls through a screen while the core rods pass out by gravity into a box provided for the purpose. Dust from the breaker is drawn into a dust arrester.

The reclaimed sand is carried by conveyors into two overhead storage bins with a total capacity of 800 tons where it is allowed to age for 24 hours. New sharp sand is

Many Manufacturers Supply Equipment

Air Compressors — Worthington Pump & Machinery Corp., Harrison, N. J.

Annealing Furnaces (design)—A. L. Stevens, Chicago.

Brick (fire, insulating, ladle, silica) — McLain Firebrick Co., Pittsburgh; Armstrong Cork Co., Lancaster, Pa.; General Refractories Co., Philadelphia; Johns-Manville Co., New York.

Car Haulers—Link-Belt Co., Philadelphia; Morgan Engineering Co., Alliance, O.

Charging Machine (open hearth) —Morgan Engineering Co., Alliance, O.

Core Breaker (rotary)—Heyl & Patterson Co., Pittsburgh.

Core Plates—Moltrup Steel Products Co., Beaver Falls, Pa.

Core Racks—American Car & Foundry Co., New York; Baldwin Locomotive Works, Philadelphia; Lucian C. Brown.

Cranes—Box Crane & Hoist Corp., Philadelphia; Cleveland Electric Tramrail Division of Cleveland Crane & Engineering Co., Wickliffe, O.; Manning, Maxwell & Moore, New York; Alliance Machine Co., Alliance, O.; Shepard-Niles Crane & Hoist Corp., Montour Falls, N. Y.

Dust Collectors—Pangborn Corp., Hagerstown, Md.

Fire Clay System—C. O. Bartlett & Snow Co., Cleveland.

Grinders—Norton Co., Worcester, Mass.

Heaters—American Blower Co., Detroit.

Hydraulic Presses — Southwark Foundry & Machine Co., Philadelphia.

Lift Trucks (hand)—Steubing-Cowan Co.

Magnets — Cutler-Hammer Co., Inc., Milwaukee; Electric Controller & Mfg. Co., Cleveland; Ohio Electric Mfg. Co., Cleveland.

Molding Machines—Beardsley & Piper Co., Chicago; Herman Pneumatic Machine Co., Pittsburgh.

Open Hearth Furnaces (design)—A. L. Stevens, Chicago.

Ore Crusher—Traylor Engineering & Mfg. Co., Allentown, Pa.

Pulverizers — Fuller-Lehigh Co., Fullerton, Pa.

Rammers (floor and bench)—Chicago Pneumatic Tool Co., New York.

Rod Straightener—American Foundry Equipment Co., Mishawaka, Ind.; Kane & Roach, Syracuse, N. Y.

Roller Conveyors—Mathews Conveyor Co., Ellwood City, Pa.

Sandblast—Pangborn Corp., Hagerstown, Md.

Sandblast Cars—Easton Car & Construction Co., Easton, Pa.

Sand Handling System—C. O. Bartlett & Snow Co., Cleveland; Link-Belt Co., Philadelphia.

Sand Mixers—National Engineering Co., Chicago.

Scales—Fairbanks Morse Co., Chicago.

Shakeout Hammers—McKiernan Terry Drill Co., New York.

Trailers—Whitehead & Kales, Detroit.

stored in adjoining bins. Conveyors carry new and old sand from these storage hoppers to bins over the sand mills. Hoppers from these bins terminate in measuring feeders which automatically control the proportion of old and new sand.

A sand control laboratory almost entirely enclosed in glass is located in position for the operators to keep a watchful eye on the sand handling system. A constant check is kept on the condition of the old and new sand and the mixture in the mills. Tests are taken for moisture, clay content, for fineness, bond strength and permeability. Sand measuring feeders over the four sand mills are controlled from the laboratory.

Prepared sand from the mills is conveyed directly to the ramming stations where it is driven into the core boxes. Surplus sand in the vicinity of the machines falls through gratings in the floor on to a conveyor which returns it to the reconditioning apparatus.

From the shakeout station the castings are taken to the rough cleaning floor where the heads and gates are removed and from where the castings are shifted into the products transfer building. Castings to be annealed are placed in a double end car type annealing furnace 10 feet high, 13 feet wide and 70 feet long on the inside and 25 feet high, 55 feet wide and 80 feet long on the outside. The difference between the inside and outside dimensions is accounted for by the regenerators and combustion chambers at the sides and ends.

This department also contains a sandblast chamber 14 x 70 feet, large enough to accommodate a one piece locomotive bed. If necessary the chamber may be divided into three by rubber curtains.

Oil is the universal fuel in this plant and is stored in an underground tank with a capacity of 500,000 gallons. A double pipe line encircles the plant with valves at each consuming station. The oil line is encased with a steam line to insure effective circulation.

Electric current is supplied by a public service company and is stepped down to the required voltage in a substation inside the plant. A boiler house on the premises supplies steam for heating and pumping.

Auxiliary departments include a building for storing and distributing oxygen and for the generation and storage of acetylene gas, a maintenance machine shop, a cafeteria, a dispensary, and offices. Dust from the dust collectors is sluiced with water to low areas on the property.

The largest users of the products have a substantial financial interest in the General Steel Casting Corp. Companies associated in the ownership include Baldwin Locomotive Works, American Locomotive Co., The Pullman Co., and American Steel Foundries. The plant adjoins that of the Baldwin Locomotive Works at Eddystone, just outside Philadelphia.

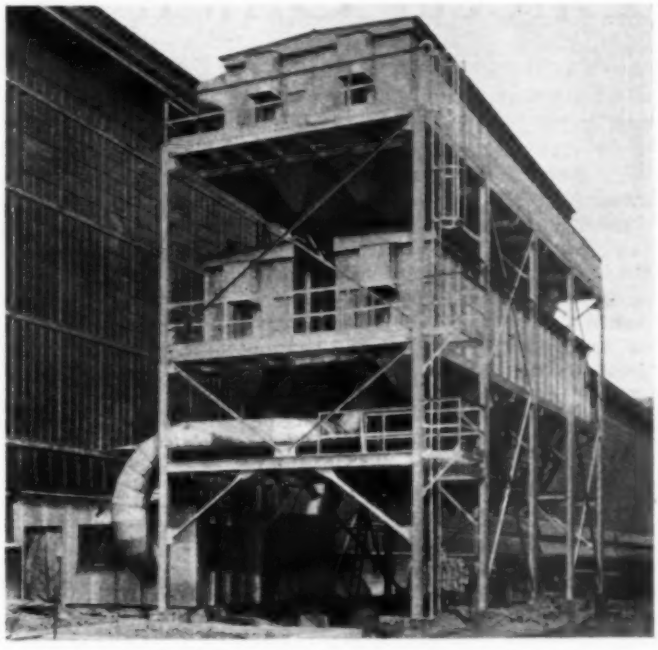


Fig. 13—The Dust Collector Installation Is Unusually Complete. The Material Later Is Sluiced to the Dump with a Stream of Water

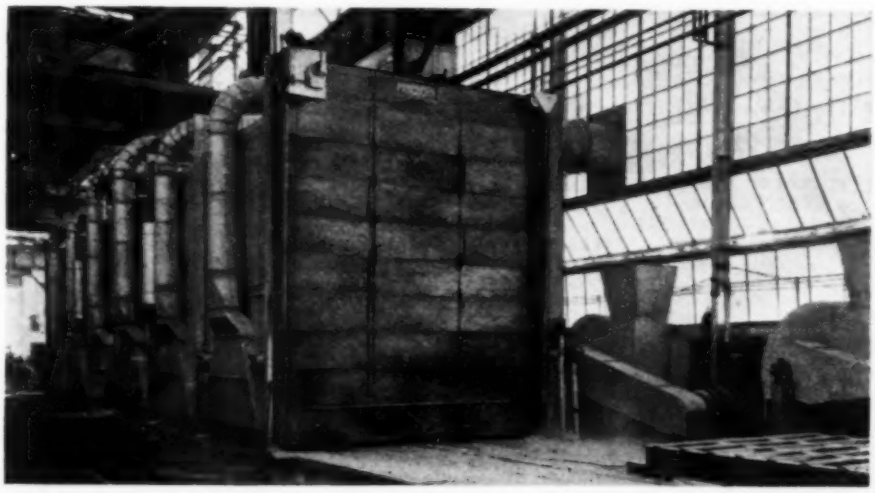


Fig. 12—Castings Are Sandblasted in a Chamber Equipped with Dust Collectors

Chicago Founders Hear Varied Program

Building of a modern tractor foundry in Russia was described by C. R. Cady, formerly foundry engineer for Frank D. Chase, Inc., and now with the National Engineering Co., Chicago, in an address April 2 before the Chicago Foundrymen's club, at the City club, Chicago. Mr. Cady supervised construction of a tractor department in the Krasny Putiloff plant, Leningrad, which was completed more than a year ago.

William Romanoff, technical superintendent, H. Kramer Co., Chicago, also was a speaker at that meeting, discussing secondary metals, and particularly brass ingot smelting and reduction as related to brass foundry practice. Mr. Romanoff declared that much of the mysticism in secondary metals production is being eliminated in favor of more open and simplified practices in that industry. He described tests which showed that secondary ingot castings had high physical qualifications. He also discussed impurities in brass ingot production and showed that some of the disputed impurities have little effect in small amounts.

Company Reorganizes

Industrial Oil Co., 619 Thirty-eighth avenue, Milwaukee, has affected a reorganization. The new officers are August G. Mueller, president and treasurer; William J. Toennes, vice president; and Henry B. Mueller, Waukesha, Wis., secretary. The company handles foundry core oils, lubricating oils and greases, linseed oil and rosin.

Declining Markets Effect Small Changes in Costs

IN THE present era of exceedingly close competition both in the buyers' and sellers' market, cost items are scrutinized more closely than ever before. It is necessary for the producer to manufacture an article that can be sold at a sufficiently reasonable price to make it desirable for the maximum number of customers. Buying, selling and producing in large volumes is one of the methods that has been used to secure the desired effect. Such a method has brought forth the fallacy that a producer can manufacture a large amount of product, regardless of method or equipment and thus secure low costs. That is not always the case for experience has shown that there is a certain production capacity in any shop which will produce the maximum income for the methods and equipment used.

Low Price Quoted

Take for example the foundry producing a type of casting, such as a cylinder block, which involves the perfection of a highly specialized technique. If a jobbing shop, ill equipped for the production of such a casting, secures an order in competition with the specialty shop, it is reasonable to assume that the former plant is quoting a price below cost since it must develop a new and specialized technique. If the jobbing shop works on the previously mentioned principle of high production to reduce costs, it will find that the idea is a fallacy, when the creditors and the sheriff arrive and take over the plant.

The Questions

HOW does the price of pig iron per ton affect the price of castings per pound, for instance, how will $1.00 per ton change in pig iron cost affect the cost of castings in cents per pound?

How much will $1.00 per ton change in coke affect castings costs in cents per pound?

How much does $1.00 per day change in molders' wages affect the cost of castings in cents per pound?

How many pounds per day will an average molder be able to put up, say in the three different groups of light, medium and heavy castings? By light castings we mean those weighing under, say five pounds. By medium those from say, five pounds to 50 or 100 pounds and heavy castings on up to say, 2500 pounds. Of course, the type of the casting and probably the core work will have something to do with the amount but we merely want average conditions, and would like to have the data if you could give it to us.

How many pounds of good castings are obtained from one ton of melted iron? This, of course, would take into consideration the sprue, gate risers, etc., as well as normal scrap.

Necessity for low production costs has produced a desire in practically all industries for investigation of cost methods. That has resulted in the more or less astounding discovery that two companies engaged in the same field of endeavor seldom have figured their costs by the same methods. This situation has led to the establishment of standard cost systems and a most thorough investigation of production methods from a cost standpoint. The foundry industry has not been a laggard in that respect. Standard cost systems now have been evolved for steel, malleable and gray iron foundries by the American Foundrymen's association, Steel Founders' Society of America, Malleable Iron Research institute and the Gray Iron institute. It now is possible for members of the same class of castings manufacture to talk in the same language when speaking of costs.

Other Fields to Conquer

An inquiry recently submitted to the editorial office of THE FOUNDRY, shows that there still is another field of endeavor which the foundryman must conquer. That is the merchandising and selling. The dissemination of information on foundry costs to customers, that they may be in a more favorable position to understand the problems of the particular foundry with which they are

Table I

Metal Cost Influenced by Pig Iron Changes

	Per Cent of Charge	Pounds Charged	Scrap Price Per Net Ton	Pig Iron Price Per Net Ton $22.00	$21.00	$20.00	$19.00	$18.00
			Cost of Charge at Varying Pig Iron Prices					
Pig Iron	40	8000	.....	88.00	84.00	80.00	76.00	72.00
Scrap and Sprues	40	8000	$12.50	50.00	50.00	50.00	50.00	50.00
Steel Scrap	20	4000	13.20	26.40	26.40	26.40	26.40	26.40
Total		20000		164.40	160.40	156.40	152.40	148.40
Cupola Loss—5 Per Cent		1000		.....	.....	.....	.....	.....
Metal poured		19000		164.40	160.40	156.40	152.40	148.40
Less Sprues, Gates and Defective Castings Reclaimed		1520	12.50	9.50	9.50	9.50	9.50	9.50
Net Metal Cost Exclusive of Cost of Melting		17480		154.90	150.90	146.90	142.90	138.90
Metal Cost Per 100 Pounds Good Castings Exclusive of Cost of Melting				.886	.863	.84	.817	.794

Table II

Charge Cost Varies

Price of Coke Per Net ton	Cost of of Coke Charge of 2703 Pounds	Cost of Coke Per 100 Pounds Good Castings Produced
$11.00	$14.87	$0.085
10.00	13.52	.077
9.00	12.16	.069
8.00	10.81	.061
7.00	9.46	.054

dealing is a worthy step. The previously mentioned inquiry presented several questions which are given in the accompanying box. The questioner operates a large machinery manufacturing plant which consumes a sizable tonnage of gray iron castings annually. Recognizing the questions as typical of the line of thought being brought to bear on castings salesmen, THE FOUNDRY invited comment from a number of well known men in the gray iron, malleable and steel branches of the industry.

Little Influence Exerted

Comments of those men have been published in the March 15 issue under the title "Striking a Balance" and in the April 1 issue as "How Declining Markets Affect Castings Costs." The answers show the large variation in methods of production that exist in different type shops. However, all agree that the effect of lower cost of raw materials influences the cost of the finished product only slightly. R. F. Nash, comptroller, Pettibone Mulliken Co., Chicago, in commenting upon the various questions, has prepared the following interesting computations to show the effect of the various price changes:

"Regarding raw materials, there seems to be a general impression among purchasers of castings that a change in the price of $1 or so per ton on such items as pig iron, coke, etc., materially affects the cost per pound of the product. In many cases, purchasing agents do not appreciate the true relationship between such commodity price changes and the ultimate cost of the foundry product. Table I shows the effect on the cost of metal of various prices of pig iron. In this case, a mixture composed of 40 per cent pig iron, 40 per cent machinery scrap and foundry sprues, and 20 per cent steel scrap has been used. For the purpose of calculation, it has been assumed that this is a 10-ton heat having a cupola loss of 5 per cent and a yield of good castings equal to 92 per cent of the metal poured.

"Pig iron prices are shown at $1 per ton advances from $18 to $22 per net ton. To simplify calculations, a net ton basis has been used throughout in the price factors and yield. Furthermore, this table reflects merely the cost of metal, exclusive of any labor, fuel, depreciation or other charges applying on the melting. A comparison of the results indicates that after allowance for the scrap value of the sprues, gates, and defective castings resulting from the pouring of such a heat, the variance in price of castings for $1.00 advance per net ton in the price of pig iron is 2.3 cents per hundred pounds.

"In Table II, the same charge, cupola loss and yield of good castings from metal poured has been used as indicated in Table I, with a ratio of coke to metal charged of 1 pound of coke to 7.4 pounds of metal. The variance in the cost of finished castings per dollar variance in the price of coke per net ton is 0.8 cents per hundred pounds.

Wages Have Effect

"Table III illustrates the variance in the price of coke pet net ton good castings per man per day, based on a varying molders' wage of from $5 to $9 a day, and varying productions per day per molder of from 200 pounds to 2000 pounds of good castings. Assuming that the output of a molder is 1000 pounds of good castings per day, a variance in cost of $1.00 a day in wages would mean a difference in the price of good castings produced of 10 cents per hundred pounds.

"Combining the results shown in the three tables, and assuming that the production of a molder is 1000 pounds of good castings per day, and that a reduction of $1 per ton in pig iron, coke and wages was made at one and the same time, the result would be a difference in the cost of finished castings of 13.1 cents per hundred pounds, divided as shown in the following tabulation.

Reduction due to pig iron price	$.023
Reduction due to coke price	.008
Reduction due to molding price	.10
Total	$.131

Mr. Nash feels that an intelligent answer is practically impossible to the question relating to the daily output of good castings for an average molder. Castings of the same weight may be so unlike in design, section, etc., that any attempt would be of no value.

Reports on Testing of Materials Published

The first volume of the New International Association for Testing Materials, recently published, is divided into four parts each dealing with the testing of a specific group of materials. Group *A* relates to metals; Group *B* to nonmetallic inorganic materials; Group *C* to organic materials, and Group *D* to questions of general importance. The reports published are not intended to cover the entire field of testing of any group, but rather to present some specially selected aspects, and to ascertain the present state of knowledge on these subjects. The reports also were prepared with the idea of promoting discussion at the forthcoming meeting which will be held in Zurich.

Group *A* volume contains 368 pages devoted to 45 reports by prominent metallurgists on testing cast iron, alloy cast irons, high temperature tests, alloy steels, fatigue tests, welded joints, notched-bar tests, testing of light alloys, thermal analysis, etc. Group *B* consists of 282 pages carrying 37 reports on natural stone, portland cements, concrete, etc. Group *C* contains 224 pages devoted to 32 reports relating to the testing of timber, paint, glue and gelatine, fuels, paper, and textiles. Group *D* has 247 pages containing 33 reports relating to questions of general importance to the three previously mentioned groups. Some of the reports deal with comparison of measurements of various types such as tensile strength, hardness, elongation, bending, etc.; relation between deformation points in tensile and bending tests; wear testing, calibration of testing machines, etc. The reports are printed in English, French or German, depending upon the official language of the country in which the author resides. All reports contain abstracts in German, English and French.

Table III

Wages Influence Castings Cost

Production of good Castings Per Man Per Day in pounds	Labor Cost Per 100 Pounds of Good Castings at $5 Per Day	$6 Per Day	$7 Per Day	$8 Per Day	$9 Per Day
2000	$0.25	$0.30	$0.35	$0.40	$0.45
1500	0.33 1/3	0.40	0.46 2/3	0.53 1/3	0.60
1000	0.50	0.60	0.70	0.80	0.90
500	1.00	1.20	1.40	1.60	1.80
300	1.66 2/3	2.00	2.33 1/3	2.66 2/3	3.00
200	2.50	3.00	3.50	4.00	4.50

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

ALTHOUGH the size and condition of the gate, particularly in green sand molds, are responsible for defective castings, still it is only fair to point out that they are not responsible for all defective castings, or even for many for which they unjustly are blamed. This particularly is true in cases where the defect may be due to one of several, or even to a combination of several causes.

Unequal sectional thickness in a casting will cause a shrinkage defect. This is due to error in design and is one of the instances in which the gate or riser, while not at fault, must be manipulated to serve as a savior. Where the riser is employed as a feeder, ferrostatic pressure exerted through the semiplastic mass, pushes the crystals together. This type of riser is shown in Fig. 40.

Riser To Solidify Last

The riser must be designed to solidify last, otherwise it may draw metal from the casting. Chills also may be used near the heavier sections. Pouring metal at a higher temperature than usual may eliminate shrinkage. The surrounding sand becomes dry and hot before solidification commences and equalizes the cooling speed throughout the casting.

Gray iron crystallizes over a range of temperatures, as pointed out in a recent article by John Bolton. It passes through a pasty stage in which the metal is part liquid and part solid. The first crystals that separate out are comparatively low in carbon and the remaining liquid therefore, is richer in that element. These primary crystals or dendrites gradually grow larger in layers and each succeeding layer is richer in carbon as shown in Fig. 38. Finally at the eutectic temperature, the residual material solidifies.

If the liquid portion of a partially solidified casting containing dendritic crystals could be drained off, a jagged cavity bounded by fernlike dendrites would appear. Where shrink cavities appear in castings, the metal may have been pulled away by gravity and contraction, as shown in Fig. 39, or by contraction alone.

Another type of jagged shrinkage cavity usually is colored yellow or blue. This is caused by gas which forced its way in after dendrite formation had commenced, or, by gas that had not escaped until crystallization had commenced.

One of the crying evils of the foundry, particularly the general jobbing foundry, is adherence to a slogan coined by the head of a famous merchandizing establishment. "The customer always is right."

The merchant and the foundryman are not in the same category. When a customer enters a store he has a choice of several articles and if the one he selects does not suit him, he can return and have it exchanged. All the articles are ready made. The merchant merely wraps them up and hands them across the counter.

A different condition exists between the foundryman and his customer. The customer distinctly specifies what he wants either by blueprint or pattern and the foundryman creates a casting, an object that in itself, never was in existence before. This casting may conform absolutely to the outward appearance of the pattern or the measurements on the blueprint, but if it fails in service through an internal flaw, the customer blames the foundryman.

The foregoing does not refer to flaws due to faulty workmanship or materials. Reference here is to faults caused by attempted violation of the natural laws governing shrinkage and contraction. In many instances the customer is not familiar with those laws, but that is a long way from saying he always is right in demanding a casting made to his specification.

Refuse in Advance

The foundryman is, or should be familiar with the changes that take place while the metal is passing from the molten to the solid state and through a range of temperature that embraces nearly 3000 degrees. He should refuse to attempt a casting which he knows in advance will develop a flaw or flaws over which he has no control.

Some foundrymen seem to think that refusal to attempt a job is a reflection on their ability. No reflection should attach to a man who refuses to attempt what his judgment and experience teaches him is outside the range of practical accomplishment. The customer in the majority of instances is not familiar with the subject and usually is willing to compromise on the design of a proposed casting if inherent flaws are pointed out to him. A surgeon will refuse to operate if he knows the case is hopeless. Why should a foundryman not take the same stand?

Eliminating from the present discussion those castings which will develop cracks, spongy areas or actual cavities despite the adoption of every known precaution for their prevention, there still remain a vast number of castings which are saved from the scrap pile by intelligent manipulation of the mold and the metal after it enters the mold.

Feed the Casting

MANY castings, on account of their shape and varying thickness of metal, do not cool uniformly and therefore the normal action of the metal in settling into a homogenous, compact mass, is interrupted. Parts that solidify first draw metal away from adjoining parts that remain liquid for a longer period. When the latter commence to solidify, no further supply of liquid metal is available and the result is a cavity in that part of the casting. To meet this condition the foundryman erects a supplementary reservoir or feeder over the thickest or highest point on the casting and fills it with hot metal. The most essential feature of this reservoir is that the neck or point of communication between the feeder and the casting remains open until the casting has solidified throughout.

One of the most widely used preventatives is a reservoir of metal varying in size and shape according to local conditions and known as a sink head, feeder or riser. Since the word feeder is the most appropriate of these three synonomous terms it will be used in any farther reference to the subject. The reserve supply of metal is designed to feed or supply the casting with additional metal to compensate for the natural shrinkage.

The question naturally may arise here: If one casting requires to be fed, why are not all castings subject to the same necessity?

The answer is that supplementary feeding only is necessary on castings of uneven section, on most bulky castings and other castings in which for any reason obstacles arise to prevent normal shrinkage.

Iron expands under the influence of heat. The expansion is gradual from atmospheric temperature up to a maximum in the molten state. If a block of iron was encased in a tight fitting crucible and heated until it melted, it would expand sufficiently to raise the lid. If the block then was allowed to cool slowly and uniformly, the molecules would readjust themselves in their former position and the block would resume its former shape and dimensions.

No Feeders Needed

Castings of uniform section, and unhindered by certain factors to be referred to later, shrink and contract normally and do not need feeders. The most outstanding member of this class of casting is the ingot mold. It is large and heavy and cast in a vertical position, and yet owing to its uniformity of cross section it passes from the molten to the solid state without any evidence of shrinkage. Normal contraction and shrinkage of course are shown by the difference in size between the casting and the mold in which it was made. The casting is smaller than the pattern employed for its production, but the metal is solid and homogenous throughout from top to bottom.

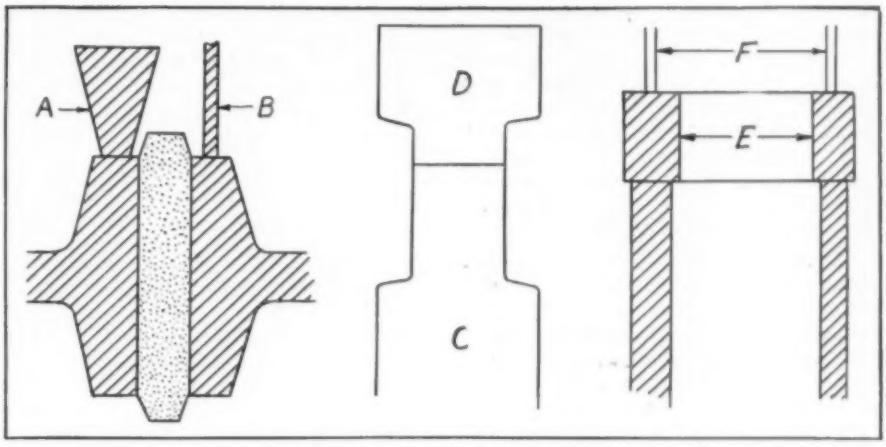


Fig 42—(A at Left)—Ordinary Type of Feeder on Wheel Hub—(D Center)—Sink Head on Roll Casting—(E Right)—Extension on Cylindrical Casting To Act as Combined Sullage and Sink Head

This casting also furnishes a useful object lesson in the important part played by gravity in the shrinkage and contraction of castings. Where the casting is poured in an upright position, gravity and shrinkage both work together to produce a solid casting. Attempts to pour ingot molds horizontally as shown in Fig. 41 invariably have failed. In some instances a porous area or an actual shrinkage cavity could be seen in the upper corner marked *G*. The illustration shows a section of the casting in the position it occupied in the mold at the time of pouring.

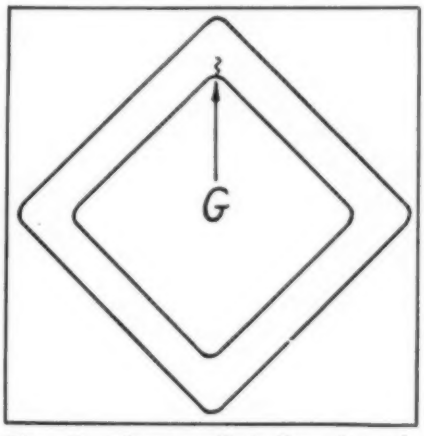


Fig. 41—Showing Defective Area in Ingot Mold Cast Horizontally

Any of these castings that passed inspection in the foundry, invariably was rejected by the open hearth department after the first heat had been poured in it. The molten steel had eaten into the weak corner and the mold either cracked, or, had to be broken away from a sticker, the local name for an ingot which cannot be stripped clean from the mold in the usual manner.

Discovered Metal Density

The explanation is that while the metal undoubtedly shrank in a fairly uniform manner, the factor of gravity diverted a little more than the normal share to the lower walls and decreased the density of metal in the highest corner.

Possibly a row of high feeders along the top of the ridge might produce a sound casting, but their preence would involve considerable expense in the foundry and cleaning department, also in the total amount of metal required. Instances are on record of ingot mold castings molded horizontally, but the molds are upended before the iron is poured into them.

In this connection it is pertinent to the subject to point to an error of judgment frequently made in diagnosing shrinkage cavities in castings with high, vertical walls, particularly those cast in green sand molds. Dry sand and loam walls, except when exposed to extra stress, usually are sufficiently rigid to resist the lateral pressure of the molten metal. Green sand is not such a stable medium and sometimes, yields.

If the sand yields gradually while the metal is rising, the only evidence is a swelled casting. If the wall holds until the mold is filled and then yields ⅛-inch or more, the result will be reflected in a swelled casting with a shrinkage cavity along the top, or, farther down depending on

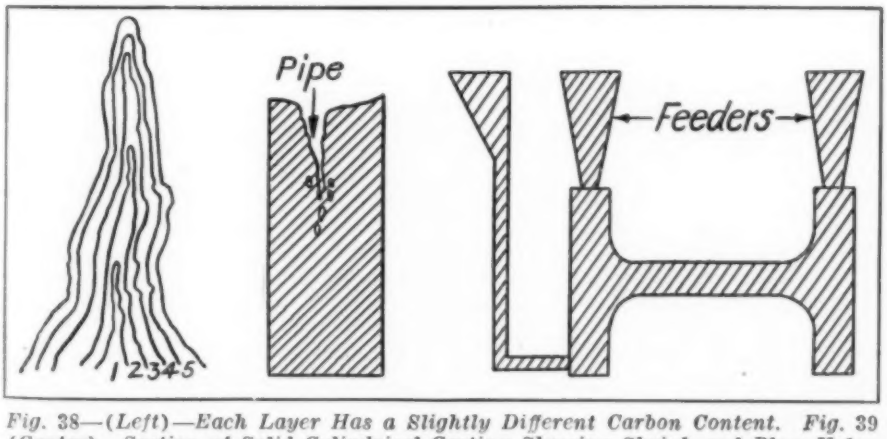


Fig. 38—(Left)—Each Layer Has a Slightly Different Carbon Content. Fig. 39 (Center)—Section of Solid Cylindrical Casting Showing Shrink and Blow Holes. Fig. 40—(Right)—Feeding Heads May Be Applied To the Rim of a Casting

the degree to which solidification had progressed when the wall yielded. The tendency is to place the blame on the iron or on the absence of a feeder, when in reality the mold is to blame. Instead of prescribing a feeder to supply the shrunken area, the logical remedy is to brace the mold or ram the sand harder to prevent the walls from yielding.

Successful feeding of a casting, where feeding is necessary, depends on two main factors: 1—An ample supply of metal in the feeding chamber and, 2—An open passage for this metal to enter the casting. These requisites should be obvious even to a person with no former knowledge of foundry practice and yet they are ignored every day by men who in other respects are competent foundrymen.

Blocks to form the feeding chambers in some instances are too small and as a result the metal in the feeder solidifies before the metal sets in the mold. So far as any benefit is concerned, the feeder might as well have been omitted. In other instances the feeder may be ample in size but the metal in it either is abused or neglected and the net result is the same as with no feeder or one that is too small.

Fill With Hot Metal

To fulfill the function for which it was designed a feeder may fall into one of two classifications: It may be large enough in cross section to remain liquid until after the casting has set, or, although smaller in cross section it may be kept open with a rod and constant addition of hot metal until the casting freezes to the top.

The first type is shown in Fig. 42 center, and is widely used on rolls and other bulky castings that may remain liquid for hours after they have been cast. The practice in cases of this kind is to pour iron into the casting until it appears in the bottom of the feeder. Roll castings, and many other large castings are poured through gates at or near the bottom. Although they are poured as rapidly as possible, the iron when it appears in the feeder, is not as hot as when it left the cupola or air furnace.

To secure the best results, it is essential that the metal in the feeder should remain liquid longer than or at least for as long a period as the metal in the casting. In roll shop practice this feature is taken care of by filling the feeder with hot metal direct from the cupola. The metal is carried either in a small ladle suspended from the crane, or, in small double shank ladles carried by two men. This fresh hot metal is poured directly into the feeding chamber and then is covered either with charcoal or with a shovelfull or two of dry blacking. In some instances it may be necessary to pour additional metal in the feeder later, but usually the feeder is calculated to hold sufficient metal at the beginning. In earlier times the practice favored the use of a smaller feeder and a small rod which was employed to keep the neck open. Modern practice favors the large feeder which requires no further attention.

Pump with a Rod

Feeding a casting through a comparatively small feeder which is kept open with a rod and fairly constant addition of hot metal is fairly satisfactory in many instances. The main objection is the tendency of the solidifying metal to close in concentric rings at the point of junction between the feeder and the casting. In some instances the opening closes gradually and the resulting metal is solid. In others the lines between the rings are apparent and constitute so many cold shut junctions. The metal in this area is neither solid nor homogenous.

In a paper presented before the American Foundrymens association in Cleveland, May 12, 1930, E. Ronceray covered many of the features involved in gating and pouring castings. Touching on the subject of shrinkage in ingots or castings he quoted from A. Portevin's *Lessons on Metallography* prepared for use in the Paris foundry high school as follows: "The conditions under which there would be no piping or shrinkage in an ingot or castings are as follows: 1—If there was no change in volume. 2—If the mass was constantly of equal temperature, the volume changes would take place at the same time on the whole mass. 3—If, although the mass is of unequal temperature, the cooling would progress by parallel layers, for example, horizontally. 4—If the cavities formed by liquid contraction were filled during the cooling period through feeding heads and pumping.

"The shrinkage in a mold is the volume change occurring from the end of feeding until complete solidification. It is contained in a zone enveloped by the isothermal lines.

"If there was no action of gravity nor influence of gating or feeding, it would be central. To avoid the cavity in the casting, the process consists in altering the isothermal lines so as to throw the contraction void away from the useful part of the casting. This is accomplished by three methods: (a) By heating certain parts of the mold through the metal stream, position of the gates, reduction in conduction power of mold walls, by dry dry sand, cores, etc. (b) by cooling certain parts of the casting with chills, cooling ribs, nails, etc. (c) By pumping with one or more feeding rods."

This is the eighth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The ninth will appear in an early issue.—THE EDITORS.

Molybdenum Progress in 1930 Discussed

Climax Molybdenum Co., 295 Madison avenue, New York, has published a booklet entitled, "Molybdenum in 1930," which gives a resume of the literature published during that year on the various uses of molybdenum. The contents of the book deal with the uses of that metal in high-speed steel, aircraft, nitriding steel, the automobile, special alloy steels, alloy steel forgings, steel and iron castings. A method of analysis for molybdenum is given and the use of that element as a catylist is discussed. Foreign comments on the use of molybdenum also are given. The booklet is well illustrated with charts, reproductions from photographs and micrographs. The latter show the effect of that element on the structure.

Book Review

Proceedings of the American Society for Testing Materials, vol. 30, 1930 in two parts, cloth, 6 x 9 inches 1336 pages in Part I and 1085 pages in Part II, published by the American Society for Testing Materials, Philadelphia, and supplied by THE FOUNDRY, Cleveland for $13.15, and in London by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster.

Part I of the *Proceedings* contains the reports of 52 different committees of the society. In addition the reports of the main committees include those of the various subcommittees functioning under those bodies. Twenty-one of the committee reports relate to ferrous and nonferrous metals and alloys. Part I also includes A. S. T. M. tentative standards submitted or revised during 1930, and tentative revisions of existing standards. The tentative standards contain 13 relating to ferrous and nonferrous metals. Those of interest to foundrymen are on chilled-tread, . cast-iron wheels; aluminum-base casting alloys in ingot form; aluminum-base alloy castings; magnesium- base alloy castings; and copper-base alloys in ingot form for sand castings. The tentative revisions include 10 relating to ferrous and nonferrous metals. Those suggested for high-test gray iron castings, chilled cast-iron wheels, and bronze bearing metal in ingot form will be of interest to foundrymen engaged in the production of those various types of castings.

Part II consisting of 1085 pages contains over 75 papers which were presented at the 1930 meeting of the society. Discussions of the various papers are included also. The presentation of the papers is grouped according to application, and the grouping include aircraft materials, metals, cement and concrete-brick and tile, rosin; paint; rubber, and miscellaneous.

Iron Reduces Crystal Size in ALUMINUM BRONZE

By Charles Vickers

ALUMINUM bronze always is classed among the strong alloys, regardless of the fact that its crystals are large. Generally, metals with large crystals are weak as the faces of adjoining crystals form planes of weakness along which the metal parts. However, aluminum bronze differs from many other metals having large crystals in that it is not weak and easily broken. Whatever substance causes aluminum bronze crystals to adhere to one another is as strong as the crystals. This is illustrated by the fact that a break in a section of aluminum bronze often runs through the crystals instead of following the boundaries, as would be the case if the boundaries were the easiest path.

Bronze Is Strong

Fig. 3 shows a rather large cluster of crystals of aluminum bronze, some of which have separated partly from the adjoining crystals along their boundary lines on heating, and have assumed the new position as they cooled and froze. Some nonmetallic inclusions can be seen but the mass is composed mainly of pure crystals of aluminum bronze, containing 90 per cent copper; and 10 per cent aluminum. The crystal located at the lower right hand corner of Fig. 3, appears to have a hole in it. That is not the case. The cavity was made by another crystal with a corresponding projection on one of its sides. When the metal parted, the crystal with the projection pulled away from the group shown, and left the indentation. Fig. 1 shows some smaller masses of crystals of which No. 5 appears to be a single crystal, but more probably consists of three separate crystals. The lines of crystal demarkation in No. 5 are difficult to find, while in the case of No. 1 they are identified easily where the crystals have started to separate. In No. 3 some of the crystals are quite small, though the one in the center is a large one, as are the bottom crystals of Nos. 4 and 2. Figs. 2 and 4 show clusters of crystals that are deeply indented, and extensively pitted with dross, which appears to have arranged itself along the boundaries of the crystals. This is alumina of the hard variety, and if a cutting tool had encountered it, the tool would not have penetrated much further.

Table I

Bronze Properties

Test Bar No.	Elastic Limit lbs./sq.in.	Tensile Strength lbs./sq.in.	Elongation in 2 Inches Per Cent
1	27,410	55,510	4.0
2	22,560	55,900	8.0
3	24,730	37,720	2.0
4	20,610	59,750	10.5
5	19,690	53,700	17.0
6	23,170	40,410	3.5
7	20,870	47,270	11.5
8	21,570	42,800	5.0
9	20,170	48,270	6.0
10	19,720	45,670	11.0
11	20,680	54,130	4.5
12	23,120	58,500	5.5

There is nothing weak about these aggregations of crystals for they cannot be broken apart by any force less than strenuous pounding with a hammer. The crystal at *A*, Fig. 3, looks as though it could be pressed out by the fingers. Many attempts have been made to detach these loose appearing crystals, but it cannot be done by the unaided fingers. This shows the strength of the adherence of the crystals. Temperature is necessary to weaken the bond between them, and when the correct degree is reached they will drop apart by their own weight. At lower temperatures, it practically is impossible to break the crystals apart.

Cylinder Is Cast

To obtain these crystals, a solid, bronze cylinder, 8 inches high, 6 inches in diameter, and equipped with a riser of the same weight, was cast in a sand mold. The casting was of considerable mass and, consequently, cooled slowly. That condition favored crystal growth. Brinell hardness of the casting was 94. It contained 10.03 per cent aluminum, 0.007 per cent calcium, and the remainder copper with no magnesium, titanium or manganese. The casting was to be remelted, but since it was of an inconvenient shape for the pots, it had to be broken. Accordingly, the

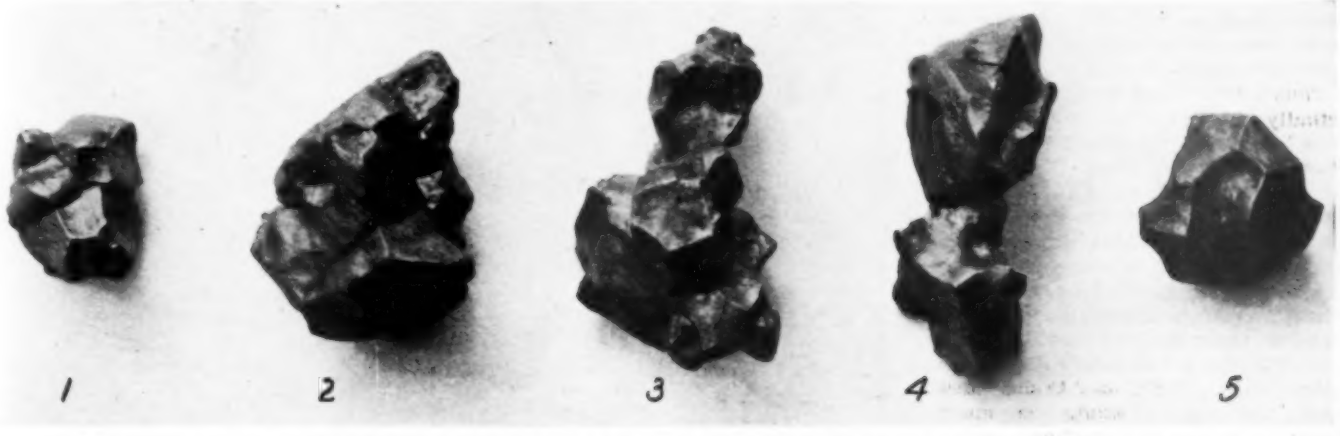


Fig. 1—Smaller Masses of Crystals Also Showing Boundary Lines. The Crystal on the Right Appears To Be Single but Probably Consists of Three Separate Crystals

Fig. 2—The Center Crystal Is Large. Dross Has Segregated Along the Boundary Lines

casting was placed in a furnace and heated. The first trials were unsuccessful as the proper temperature was not reached and the sledge merely battered the casting, producing little impression since aluminum bronze is ductile at a cherry red. Finally, it was brought almost to the melting point and had to be handled carefully to get it out of the furnace. At this point, when the casting was struck with a sledge, the outer skin peeled away where the blow was struck, and out tumbled crystals of various sizes and shapes. Some of the crystals were in clusters but those near to the center of the casting, rolled out singly since that section was hottest. A few blows of the sledge reduced the tough mass of metal to a heap of crystals, and clusters which, when cool were shovelled into a crucible ready for melting.

Physical Properties Given

Physical properties of a bronze of the previously mentioned composition will range from 50,000 to 65,000 pounds per square inch, with elongation from 7 to 20 per cent, depending on the cooling time from the molten state. The time factor in cooling is highly important. The longer the cooling period, the lower the physical properties will be, and vice versa. Single, cast-to-size, test bars would show results much too high for safely judging the load for such a casting as this cylinder, which from its nature had to cool slowly. Table I shows the physical properties of massively cast 10 per cent aluminum bronze, treated with 0.5 per cent alumino-vanadium containing 10 per cent vanadium.

Thus a 10 per cent aluminum bronze actually will average around 50,000 pounds tensile strength; 22,000 pounds elastic limit, and about 7 per cent elongation in 2 inches in the case of a gear casting weighing 80 to 100 pounds. Those figures represent an average of 12 separate tests, and are the maximum figures to be considered when figuring in connection with this class of material.

If the physical properties had been taken from single, cast-to-size, test bars, the results would be much higher, because the castings would have cooled more rapidly, and the crystals would have been smaller. This is one of the peculiarities of the 10 per cent aluminum bronze. Its strength depends upon the length of time that elapses in passing from the molten to the solid state. This change in strength brought about by slow cooling has been termed *self annealing* by the author, because a similar condition may be produced in an aluminum bronze casting by annealing. When the change occurs during the time a weighty casting is cooling in its sand mold, it must proceed of its own volition, and therefore may be called *self-annealed*. Although the word annealed may not be exactly a happy one to apply to this change, as it usually is applied to a softening and strain-releasing effect, it is the only word that has been used to denote this change. In the case of aluminum bronze, it means the reverse of the usual definition, since it applies to a hardening effect, combined with a loss of ductility in the bronze.

Experiments With Annealing

When aluminum bronze became a commercial alloy, this odd change soon was noted by the brass founder. Test coupons attached to large castings failed to reach the specifications shown possible by the singly cast test bars from which the physical properties of the alloy had been judged. To account for this phenomena, it was the author's belief that larger castings should be annealed to relax casting strains similar to the practice used for steel castings. An opinion was expressed that a soaking pit should be provided into which the red hot castings, as they came from the sand molds, could be placed to cool gradually. Before incurring the expense of building such pits, common sense suggested that experiments should be performed to determine whether the improvement in physical properties would equal expectations. An electric muffle was requisitioned and first was brought up to what was thought would be the temperature at which the castings could be removed to the pit. Obviously, the castings would have to cool in the mold sufficiently to be strong enough for handling without danger of breakage.

Bronze Was Brittle

In the case of aluminum bronze, this temperature was considerably higher than would be safe for a tin bronze. The temperature used was a full cherry red which is before the castings start to shrink. This is the point at which aluminum bronze die castings must be removed from the dies. If they are not removed before they shrink, they either wedge fast in the dies or are broken. The castings were removed from the sand molds and quickly were placed in the muffle. Heat in the muffle was continued sufficiently long to permit the temperature of the castings and that of the muffle to reach the same point. The heat then was shut off, and the muffle and contents allowed to cool normally to room temperature.

The result of the experiment was not according to expectations. In fact, it was quite opposite. One of the castings was dropped on the floor accidentally and was so brittle that it broke into several pieces. This was a revelation

Fig. 3—Cluster of Aluminum Bronze Crystals Showing Crystals Separating Along the Boundary Lines

that showed astounding possibilities for slow cooling. If carried to completion, the castings might be little better than glass. It also showed that the soaking pit idea was wrong for that alloy. The same result will be obtained with what is known as No. 5 bronze which contains 89 per cent copper; 10 per cent aluminum; 1 per cent iron. It is possible to prolong the cooling period of castings made of that alloy until they are practically worthless. Chunky castings of the 10 per cent aluminum, low iron alloys should be stripped from the mold as soon as possible after pouring, and should be allowed to air cool. In some cases cold water may be used to hasten the cooling. What can be expected from test coupons cast attached to a casting weighing 100 pounds, of the alloy copper, 89 per cent; aluminum, 10 per cent; iron, 1 per cent, is shown by the following example. Test bars were cast as coupons attached to a casting weighing 100 pounds. The coupons later were turned to test bars of standard dimensions, pulled and averaged. The physical properties shown in Table II were realized.

Alloys Should Be Chosen

There are alloys of aluminum bronze that are not subject to the phenomena of self annealing. These will be treated in a future article. The mixture copper, 89 per cent; aluminum, 10 per cent; iron, 1 per cent is only suitable for small castings, such as die castings which are cooled rapidly and retain their maximum strength. There are founders who use the alloy for large castings, and go to the expense of heat-treating the alloy to fit the castings for the purpose intended. That is an operation which is both costly and unnecessary since a selection can be made of other alloys of aluminum bronze which will produce castings which will come from the sand possessing the same, and even better properties than the heat treated 89-10-1 alloy. Those other alloys also can be heat-treated and further improved.

Probably the first heat-treatment of aluminum bronze was carried out by A. Portevin and G. Amon, who described their work in an illustrated article *Revue de Metallurgie*, vol. 13, 1916. Two alloys of aluminum bronze were studied. One contained 89.85 per cent copper; 9.95 per cent aluminum and 0.10 per cent zinc, and the other 88.8 per cent copper; 10 per cent aluminum; 1.1 per cent manganese, and 0.05 per cent zinc. Tests showed that when those alloys were quenched below 932 degrees Fahr., the mechanical properties were not altered. However, if they were quenched from above the eutectic temperature, from 1112 to 1652 degrees Fahr., the alteration produced is a function of the temperature from which the quenching took place.

Tensile Strength Increases

After quenching from 1472 degrees Fahr., annealing at 752 degrees Fahr. causes an increase in hardness and tensile strength. The annealing effect is obtained quickly at 932 degrees Fahr., and at 1112 degrees Fahr., especially with bronze containing 89 per cent copper; 10 per cent aluminum, and 1 per cent manganese, which is quite similar to the 89 per cent copper; 10 per cent aluminum and 1 per cent iron alloy. If the latter alloy is quenched in cold water from 1652 degrees Fahr., and then is reheated to around 1260 degrees Fahr., and allowed to cool slowly its tensile strength will be increased to approximately 90,000 pounds per square inch, its yield point will be raised and its elongation lowered. However, the same properties can be obtained from a sand casting, by changing the mixture. Therefore, instead of casting the 1 per cent iron alloy, the foundryman should start with the strongest and most suitable alloy, and then heat-treat if necessary. This is a point worth studying by the aluminum bronze founder.

As previously stated, a metal that possesses large crystals usually is weak and brittle as in the case of antimony, bismuth, phosphor-tin and cast zinc. Metals of that type that are used as a base for other alloys must have their crystals broken up by the addition of some suitable metal. For instance, zinc crystals are broken up by the addition of 10 per cent copper. An alloy of copper, 10 per cent; aluminum, 5 per cent; and zinc, 85 per cent, makes an extremely useful alloy with a tensile strength of around 37,000 pounds per square inch. Similarly, if the crystals of the binary alloy of aluminum and copper are broken up, much stronger alloys are formed. Iron appears to be the most suitable element to bring about this change in the case of aluminum bronze.

Table II

Properties of Bronze Alloy

Copper, 89 per cent; aluminum, 10 per cent; iron, 1 per cent

Massive Cast

Ultimate strength	53,100 pounds per square inch
Yield point	25,500 pounds per square inch
Elongation	8.0 per cent in 2 inches
Reduction of area	11.8 per cent
In compression—	
Elastic limit	23,000 pounds per square inch
Per cent compression, after load of 100,000 pounds per square inch	13.5 per cent.

Light Cast

Ultimate strength	78,500 pounds per square inch
Yield point	28,900 pounds per square inch
Elongation	20.0 per cent in 2 inches
Reduction of area	17.6 per cent
In compression:—	
Elastic limit	19,000 pounds per square inch
Compression after load of 100,000 pounds	13.8 to 14 per cent

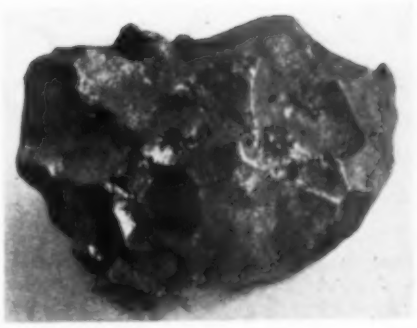


Fig. 4—Dross Shown on This Crystal Is Alumina of the Hard Variety

Iron Operates Differently

In this latter alloy, iron operates quite differently from its action in the copper-tin bronzes. This difference is due to the affinity of iron and carbon. When the two are combined, they are insoluable in molten copper, and are diffused throughout the metal until they are frozen as hard spots which damage the tools used in machining the castings. However, aluminum breaks up this combination of iron with carbon, and when copper is present in quantity it expels the carbon, and forms a ternary alloy of copper, iron and aluminum, from which the carbon can be skimmed as graphite.

In making alloys of iron aluminum and copper, in which the iron is quite high, it sometimes is more convenient to take advantage of the lower melting point of cast iron, as compared with wrought iron. Although, in the absence of aluminum, iron will separate from the copper on cooling, the presence of aluminum insures that a perfect triple alloy will result. It is for this reason that no difficulty need be feared in alloying iron with aluminum bronze to produce finer crystals, than the ones shown in the illustrations.

William G. Praed has been appointed radiograph engineer in charge of the commercial x-ray laboratory recently established by the Claud S. Gordon Co., 708-14 West Madison street, Chicago. Mr. Praed formerly was associated with the Bethlehem Steel Co., Bethlehem, Pa., and later with the Link-Belt Co., Indianapolis as assistant to the general superintendent.

GRAY IRON

Possesses

Valuable Engineering Properties

CORROSION losses cost the users of metal products many millions of dollars each year. Rust, iron's greatest enemy, takes its relentless toll. Coatings, provided by painting, galvanizing, coating with asphalt, use of phosphate and dichromate solutions, etc. are used for protection against corrosion, but they are not always thorough and lasting. Water is the most common fluid and water rusts iron. In addition to water, many corrosive fluids such as oil, acids, alkalies, etc. are used in the chemical industries. Indeed, some corrosive fluids are used in nearly every manufacturing establishment. Gray iron is employed widely in machinery and in equipment of many kinds and its corrosion resistance is a subject of wide interest.

Cast Pipe Widely Used

Use of cast iron water pipe dates back many years. The famous fountains at Versailles were installed about 100 years before the Declaration of Independence and part of the original cast iron piping system is still in use. Today cast iron remains the most widely used material for water main and soil pipe. Under most conditions its corrosion resistance is much greater than steel, and its cost lower. Cast iron pipe is heavy, it withstands high crushing loads, so long as these are equally distributed and do not bend the line.

It is used successfully for the ordinary pressures employed in water mains. Where stray currents do not cause electrolysis and where soils are not unusually corrosive, cast iron pipe usually gives good service for almost indefinite periods. Is the type or quality of iron a factor in its life in water service? Apparently not. Many investigations have been conducted, including the extensive studies by the bureau of mines. One of the recent papers on this subject is that by H. O. Forrest, in the *Proceedings* of the American Society for Testing Materials, 1929. He concludes, "It is evident that the rates of corrosion of the usual types of cast iron made in this country do not vary sufficiently to cause any great differences in length of life."

Although gray irons of different grades do not vary much in their degree of corrosion with a given water, different waters vary quite widely in their attack on gray iron. In some cases it has been found desirable to *doctor up* or chemically treat certain waters to minimize corrosion. Similarly different soils vary quite widely in their corrosive action on gray irons. Pipe manufacturers use various asphalts, special cements, etc. as protective coatings to minimize pipe corrosion.

Problems encountered in handling corrosive fluids and solutions are legion. To all with experience in handling such fluids it is obvious that none but general observations can be offered. Nature of the fluid, concentration, temperature, pressure, and presence of impurities all have an influence on the corrosive action. Parallel installations have been made with identical materials in each and presumably like fluids, where success and long life was obtained on the one and rapid failure occurred in the other. One case is particularly vivid where two plants were practically across the street from one another, positively identical materials were employed in both installations, both processes were the same, yet due to some vague unknown influence (not electrolysis) entirely dissimilar results were obtained.

It must be remembered that corrosion is comparative. It is maximum resistance per dollar that is wanted. Platinum is more resistant to most fluids than cast iron is, but it is obvious that between the two if the resistance of the iron is such that it can be used at all it will find favor.

Some Oils Are Corrosive

Aside from water, petroleum oils and their products are the most widely distributed fluids. Petroleum oils do not rust iron, in fact they form semiprotective coatings which partially prevent the access of the water and air which cause rusting. Many crude oils and products made therefrom, are comparatively noncorrosive and are handled with ease. Some oils of high sulphur content cause more trouble. However, gray iron and steel are more resistant to the action of these latter oils than most of the nonferrous metals, and in addition are much less expensive. The choice of gray iron or of steel for a given purpose depends a great deal upon the mechanical suitability of the respective metals and on their cost. Many tons of pipe, valves, fittings, and other gray iron equipment is used in the oil fields, although this tonnage is overshadowed by the vast volume of fabricated steel products. Many gray iron castings are found in oil refinery equipment. However, the modern tendency toward higher temperatures and pressures in newer *cracking* processes has caused wholesale substitution of cast and wrought steel equipment for many of the former gray iron castings.

Gray iron castings are used in the handling of natural gas and in the manufacture and handling of artificial gas. Here again mechanical suitability and cost are the governing factors in choice between iron and steel, since the corrosion problems as a rule are handled equally well by either type material.

Sulphuric acid has been termed the backbone of the chemical industry. Its consumption is used as a barometer or index of activity in this industry in the same way that the con-

Corrosion and Wear

PRACTICALLY every manufacturing establishment uses some corrosive fluids for carrying on its processes, and in consequence the problem of corrosion of equipment arises. Gray iron of the proper quality resists certain types of corrosion remarkably well as is pointed out, and for that reason finds many engineering uses. Wear is another factor in engineering uses of materials, and due to the various types that can occur, the term must be qualified. Metal to metal wear is involved in all machinery, and that particular phase also is discussed in this article.

sumption of steel is used as a barometer of the trade activity in the metal working industries.

Strong or concentrated sulphuric acid (often called oil of vitriol), approximately 95 to 100 per cent pure, is a colorless, heavy, oily-looking liquid, whose specific gravity is 1.84 (water = 1 00) and is 66 degrees on the Beaume scale. It is miscible with water in all proportions and acid containing water is termed dilute acid. A solution containing 78 per cent sulphuric and 22 per cent water is 60 degrees Beaume. The common method of expressing the concentration or strength for acids 50 per cent and below is by percentage.

Strong Acid Lowers Attack

Sulphuric acid is manufactured by two processes, namely the chamber process and the contact process. In either of these processes, where the acid is 60 degrees Beaume or over, and is not extremely hot, it may be handled satisfactorily in cast iron. An exception is where the acid must be of high purity, and a trace of dissolved iron objectionable. However, dilute sulphuric acid attacks gray iron rather rapidly. The explanation of this seeming anomaly lies in the solubility characteristics of ferrous sulphate. When gray iron is exposed to the action of sulphuric acid, ferrous sulphate is formed. Ferrous sulphate is nearly insoluble in strong sulphuric acid, but readily soluble in water. Thus in strong acid the sulphate coating remains and protects the iron, whereas in dilute acid the sulphate is dissolved and the reaction proceeds.

Although gray iron is suitable for handling strong 66 degrees Beaume sulphuric acid, all grades cannot be used for fuming sulphuric acid, or oleum. This acid, consisting of excess sulphur trioxide dissolved in strong sulphuric acid, sometimes decomposes open grain cast iron rapidly. Cases are known where vessels have cracked or burst. The sulphur trioxide apparently oxidizes the silicon of the iron to SiO_2, which swells up and cracks the metal. Thus, the action has some resemblance to certain types of *growth* phenomena.

The strong dense grades of iron comparatively low in total carbon and silicon are most acid resistant. Special types of cast iron have been devised for acid and other corrosive services. The high silicon irons contain about 14 per cent silicon and are quite resistant to dilute acids as well as to concentrated acids. However, it is stated that oleum or fuming sulphuric acid acts upon them in the same manner as it does on regular cast iron.

While the high silicon irons possess excellent corrosion resistance to many media their fragility and brittleness are a source of annoyance and trouble. They are difficult to cast and are almost unmachinable. The new austenitic type cast irons possess fairly good resistance to most concentrations of sulphuric acid. These irons usually contain 14 to 20 per cent nickel, 4 to 7 per cent copper and up to 2 per cent chromium.

Wherever the acid is 60 degrees Beaume or over, gray iron may be found suitable. In presence of other inhibiting agents gray iron sometimes is used for even lower acid concentrations. A point to be remembered is that sulphuric acid is deliquescent, that is to say it picks up water. Thus lines open to the air may cause trouble due dilution of acid and consequent attack.

Iron Pots for Nitric Acid

Nitric acid production ranks next to sulphuric acid production in acid manufacture. It is used in many commercial processes. Among these are synthetic dyestuffs, pryoxylin plastics, nitro-cellulose rayon, explosives, fireworks, and electroplating. The common method of manufacture of nitric acid consists of heating sulphuric acid and sodium nitrate in gray iron pots or retorts. The products are nitric acid and sodium sulphate. Strong nitric acids and mixtures of nitric and sulphuric acid (*mixed acid*) attack gray iron quite slowly. *Mixed acid* is widely used in several of the processes mentioned above.

Dilute nitric acid attacks gray iron rapidly. High silicon iron is resistant to both strong and dilute acids. Probably the best material for handling nitric acids of various concentrations are the stainless irons and steels containing 14 to 30 per cent chromium. These metals possess excellent resistance to attack and are strong and tough. Where their initial cost is not too high they are being used extensively. Hydrochloric acid (often called muriatic acid) is not handled successfully in gray iron.

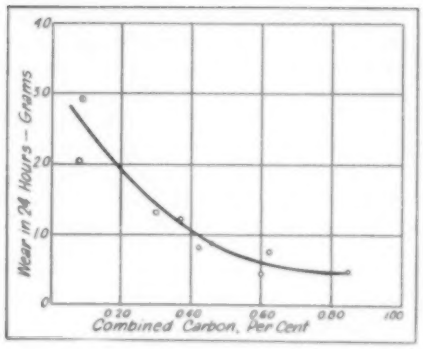


Fig. 104—Influence of Combined Carbon on Wear of Iron

Gray Iron Resists Caustics

Gray iron is used widely and successfully in the handling of caustics and alkaline solutions which are used in the manufacture of glass, soap, viscose rayon and other textiles, petroleum oils, and gasoline, sodium silicate, glycerine, paper manufacture, and dyestuffs. Even in strong boiling caustic solution the attack is slight. Gray iron equipment finds many applications in alkali manufacturing establishments, even being used for caustic fusion kettles. Iron or steel are used for alkaline liquors according to the physical characteristics needed. The high-nickel, austenitic cast irons are even more resistant to caustic and alkalies, than ordinary gray iron—in fact some grades are hardly tarnished by boiling caustic or lye.

While the review of corrosion problems is necessarily brief, it may suggest to the foundryman some of the more typical corrosive conditions for which gray iron castings are suitable. Obviously there are many more applications for this metal. Dense close grained castings are always desirable.

The term wear resistance, like the term hardness, is not defined easily as there are various types of wear, hence various types of wear resistance. Possibly we can define as wear resistance that property or combination of properties which enables a material to resist surface disintegration by mechanical action. That in a way parallels a definition of surface corrosion resistance as resistance to surface disintegration by chemical attack.

Wear of bearing surfaces is measured by disintegration caused by two metals rubbing on one another. Wear of a sandblast nozzle is measured by the resistance of the metal to the at-

Table XV

Types of Wear Are Varied

Type of Wear	Example
Unlubricated sliding surface contact	Brake shoe on car wheels
Lubricated sliding surface contact	Plain bearings; Piston against cylinder
Rolling unlubricated	Car wheel on tracks
Rolling lubricated	Roller and ball bearings
Crushing nonmetallic abrasives	Rock crusher jaws
Abrasion by nonmetallics dry	Steam shovels
Abrasion by nonmetallics wet	Pumps handling wet sand
Soft materials against steel lubricated where soft material is renewed continually	Copper wire drawing
Soft materials against steel unlubricated where soft material is renewed continually	Flyers used in silk spinning

trition of the sand particles. Since all machinery has parts which slide or move over one another, most wear problems involve the relative wear resistances of various metals in metal to metal contact and that will be discussed in this article.

Wear, or the converse, wear resistance depends on various factors among which are (1) The types of metals involved that is gray iron on steel, bronze on steel, *hard* gray iron against *soft* gray iron, etc. (2) The presence or absence of lubrication. In theory if the lubricant film is perfect and the lubricant is free from foreign matter there is practical freedom from wear. Wear results from breakdown of the lubricant film or the presence of grit or abrasive in the lubricant. (3) The pressure intensity between the surfaces in contact. As pressure is increased the more intimate contact between the metals causes them to cling more tightly together. Finally a point is reached where the metals seize.

Tabulates Types of Wear

Some metals, like soft steel for example *gall*, they partially weld together and stick tight. The action is like that seen when two bars of soft taffy are rubbed together. On the other hand some other materials like gray iron or nitrided steel do not *gall* readily but *spall*. Small pieces break off the surfaces and cause severe cutting. While there are many exceptions the more ductile materials tend to gall, the more brittle to spall and cut. Other factors relating to wear include the finishes of the contact surfaces; the speed of relative motion; the surface temperature, and whether or not the motion is reversed.

Boegehold, *Proceedings* of the American Society of Testing Materials, 1929 has listed several types of wear as shown in Table XV, and it is obvious that each service condition involves variables peculiar unto itself. For that reason there is no universally satisfactory wear test nor is it possible to predict wear resistance from hardness or strength.

It has been known for many years that most gray irons possess excellent wear resistance, and in metal to metal wear gray iron shows up as one of the best ferrous metals, either as used upon itself or in combination with certain other metals. A reason for this lies in the relative freedom of gray irons from galling—which in turn can be attributed to extremely heterogenous structure, low ductility, and the presence of graphite flakes. In this connection it may be well to describe some breakdown tests which were conducted by Bolton and his associates.

In those tests completely reversed motion, in contact, was obtained. Speed was slow, about 10 inches per minute. Test pieces were run 25 cycles with 25 pounds per square inch load; load raised to 50 pounds per square inch, 25 cycles more run, and so on, gradually increasing the load and running 25 cycles at each load. The test pieces were examined at the end of each 25 cycles. The preliminary tests were at room temperature. While tests of many alloys under various temperature conditions were involved, for the present purpose it is sufficient to describe the action of gray iron upon gray iron.

At low pressures there was a slight glazing. As the pressure was increased the surfaces became coated with black shiny graphite. Further pressure caused light flaking of the surface, graphite pits were revealed and graphite coating was heavier. Greater pressure caused heavier flak-

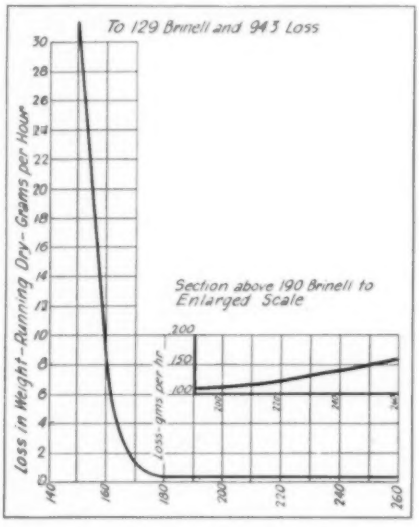

To 129 Brinell and 943 Loss
Loss in Weight-Running Dry-Grams per Hour
Section above 190 Brinell to Enlarged Scale
Loss-gms per hr.

Fig. 105—Relation of Brinell Hardness to Wear of Cast Iron

ing or spalling and cutting. This action increased and scoring became quite heavy. However, even at 600 pounds per square inch there was no decided siezing or marked evidence of galling. The action consisted of surface disintegration.

During these tests it was noted that materials which were more resistant to galling action (gray iron, certain bearing bronzes, nitrided steel, etc.) formed surface coatings —graphite in case of gray iron, apparently reddish brown copper oxide in case of bronzes, and a light brown oxide or rust in case of nitrided steel. Certain other metals which galled readily, such as stainless steel, certain white irons, rod monel and yellow brass showed little or no tendency to form such surface coatings.

The tests indicate: (1) A glazing action at low pressures. That also has been noted by Hurst, Lowry and many others; (2) the deposition of to gall and seize, and (4) the nature tendency to spall and cut rather than to gall and sieze, and (5) the nature of the action apparently depends on pressure intensity. Wear of freight car wheels and brake blocks was investigated by a committee of German iron founders and railroad authorities. Their general conclusion was that a pearlitic structure with a hardness of 180-220 brinell is best.

Results by Lehmann, *Giesserei Zeitung*, Nov. 1, Nov. 13 and Dec. 1, 1926, from the frictional wear tests led him to conclude that (1) wear resistance increases with the pearlite content; (2) formation of a glazed surface adds to wear resistance; (3) steadite, being brittle breaks off and has a harmful abrasive action; (4) in cast iron to cast iron wear the lubricating action of the graphite increases wear resistance, and (5) there appear no direct relationships between brinell hardness and wear, between chemical composition and wear, and between machinability and wear.

Kuehnel *Geisserei Zeitung*, Oct. 1, 1927, pointed out that much better wear resistance on locomotive cylinders and cylinder rings was obtained when there was a difference in hardness between rings and well, and rings under 140 brinell gave poor results. Both Lowry and Piwowarsky claimed that increase in phosphorus adds to wear resistance.

Metals Seize at High Temperatures

From his tests on automotive irons, Boegehold, Proceedings of the A.S.T.M., 1929, concluded that "Wear of automobile engine cylinders can be reduced most by proper lubrication and elimination of abrasive materials. Faulty lubrication will be more disastrous to low combined carbon (i.e. ferritic) irons than to those high in combined carbon i.e. pearlitic)." His results are summarized in Fig. 104. Boegehold's tests were carried out with a sliding speed of 1600 feet per minute under a load of 12 pounds per square inch. Each point on the diagram is an average of ten tests. The irons with varying combined carbon content were tested in contact with an iron of 180 brinell hardness and a combined carbon content of 0.46 per cent. Coyle's results are shown in Fig. 105. He found irons of a pearlitic matrix most resistant to wear.

N. L. Mochel, *Proceedings* of the A.S.T.M., 1928, conducted an investigation on the seizing of metals at elevated temperatures. His tests were run at 750 degrees Fahr. with a load of 20 pounds per square inch. The smaller of the 2 circular specimens was 1 inch in diameter and operated at a speed of nonreversed motion of 235 revolutions per minute. Comparison of the results on the rotating or upper 1 inch specimen indicated: (1) Monel metal stainless iron, nickel, and rolled carbon steel seized readily operating on themselves. (2) Six grades of gray cast iron, nickel, bronze, chrome

plated steel and nitrided steels did not seize when operated on themselves. (3) Cast irons behaved satisfactorily on all materials (monel, stainless iron, nickel) against which they were operated. Tests on other combinations are not indicated.

General conclusions which are offered tentatively on wear of gray iron are: For many conditions of nonlubricated metal to metal wear, irons of pearlitic or sorbitic matrix with fine grain size offer good wear resistance. That conclusion is substantiated by experience and observation of automotive sleeves and cylinders, machine tool gears and certain other wearing parts such as heavy bearings, and by conclusions of others regarding diesel cylinders, locomotive cylinders and the like. Also, irons of pearlitic matrix, evidently spall somewhat less readily than irons of ferritic matrix. This is in part attributable to their greater hardness but it is believed that their usual greater strength adds to resistance to spalling.

Abrasives Promote Heavy Wear

Gray irons do not resist attrition by abrasives such as sand nearly as well as white irons. Where pressure intensities are low excellent wear performance in soft open grain ferritic irons has been observed. That condition may be regarded as exceptional. Phosphorus, forming hard steadite particles, quite probably adds to wear resistance in some types of service. However, once the brittle steadite particles drop out they cause a severe abrasive action. Cast iron when properly finished and worn in, wears well in combination with certain materials which tend to gall readily on themselves such as soft steel and monel metal. When used with soft materials, such as bronze or rod brass, cast iron is likely to cut the other material up badly unless the parts are smoothly finished and worn in carefully.

The good wear resisting qualities of gray iron are not fully recognized by many, and a little experimenting here and there quite probably would suggest more general application of gray iron for many services where good wear resistance is desirable.

This is the sixteenth article of a series on the engineering properties of gray iron. The fifteenth appeared in the April 1 issue, and the seventeenth will appear in an early issue.

THE EDITORS.

Classifies Gray Iron Mixtures

ADDITIONAL results obtained from a series of test bars submitted by member foundries, recently has been published in technical bulletin No. 3, by the Gray Iron institute, Terminal Tower building Cleveland. Information on the same subject given in bulletin No. 2, and abstracted on page 74 of the March 15 issue of THE FOUNDRY, deal with the metal mixtures and chemical compositions used in the individual foundries and no effort is made to seggregate the different mixes and compositions used for the same class of castings. That work has been accomplished and is presented in bulletin No. 3.

Pig Iron and Scrap Mixtures Used

In that report, castings are grouped in 13 different classes as follows: Machinery, frames and bearings, heavy duty castings, locomotive and marine engine parts, automobile and cylinders, gears, hard wearing castings, pipe and valves, miscellaneous hardware, pumps, stove and furnace castings, municipal castings, and miscellaneous. Some of the groups are divided further into subclasses. Castings are grouped into types and mixtures. Physical properties are listed in order of increasing weight.

Machinery castings have been divided into four subclasses as follows: Agricultural; general, light medium and heavy; machine tool parts, light medium and heavy; and miscellaneous fittings for moving parts. In general the same principles of proportioning silicon and steel for varying strength and insuring soundness are followed in all classes. Castings under 5 pounds are made uniformly from pig iron and scrap mixtures. From 50 to 60 per cent pig iron proportions prevail with silicon in the 2.20 to 2.75 per cent range. Higher phosphorus pig irons generally are used to secure fluidity. Phosphorus content runs from 0.40 to 0.60 per cent in the castings. With high pig iron mixtures, it is not difficult to keep the sulphur below 0.08 per cent and manganese over 0.60 per cent giving a transverse strength of 1800 to 2100 pounds per square inch and a deflection of 0.26 to 0.30 inches. With an increase in weight of the castings to 25 pounds, pig iron percentage in the mixes is reduced to 40 per cent and silicon to 2 per cent with little change in the remainder of the elements. Steel seldom is used up to this point.

Beyond the 25 pound limit, increasing proportions of steel are noted but in numerous cases pig iron and scrap mixtures still are used. Pig iron is lowered in mixtures for castings which averaged 75 pounds but additions of ferromanganese appeared to compensate for lack of manganese in the scrap. Nickel additions to the ladle also are made. Silicon content ranges from 1.60 to 1.80 per cent. In mixtures which must serve a wide range of work, such as from 1 to 1000 pounds, the smaller castings are favored by keeping the silicon around 2.20 per cent with 40 per cent pig iron or increasing the pig iron ratio and using lower silicon throughout. Two methods of mixing are noted for castings in the 75 to 300 pound class. In the first, the silicon in the casting is kept at 2.00 to 2.20 per cent with 33 1/3 per cent pig iron and the remainder of the charge consisting of foundry returns and No. 1 machinery scrap. The second consists of keeping the pig iron content over 50 per cent and lowering the silicon to 1.80 per cent. Physical properties of both mixes are about the same with 1800 pounds per square inch transverse strength and 0.26 inch deflection.

Steel Contained in Mix

Usual practice for general machinery castings averaging between 300 and 1000 pounds is to keep the silicon under 2.00 per cent and the pig iron in the mixture between 50 and 55 per cent. All machinery castings over 1000 pounds contain steel in the mixture. The largest castings reported in that class weigh 8000 pounds and are cast from a mixture containing 30 per cent steel and 40 per cent pig iron. The mixture analyses 1.26 per cent silicon, 0.60 per cent manganese and 0.30 per cent phosphorus. While steel occurs in mixtures for practically all classes and ranges of machinery castings, the most general use is in machine tool parts. Regardless of the varying percentages of steel, ranging from 5

to 25 per cent, pig iron content remains constant at 50 per cent and silicon at 2.00 per cent. Steel in the mixtures increases as the average weight and thickness of section of the casting increase. Phosphorus is low while manganese runs as high as 0.92 per cent. Gradual lowering of the silicon from 2.00 to 1.40 per cent occures in machine tool castings in the 300 to 800 pound class as the weight increases. Steel is kept within the previously mentioned limits. Transverse strengths vary from 2200 to 2600 pounds per square inch while tensile strengths vary from 25,000 to 35,000 pounds per square inch. Mixtures for machine tool parts averaging over 800 pounds contain 30 per cent pig iron with steel up to 40 per cent. Special alloy pig irons and nickel also are used.

Bearings High in Carbon

Frames with heavy sections and those that are intended for heavy duty are made from metal mixtures in which the silicon is kept under 2.00 per cent. As the castings become heavier, silicon is reduced until when 8000 pounds is reached that element amounts to approximately 1.26 per cent. All mixtures contain steel and ladle additions of ferromanganese are used where the manganese content of the iron falls below 0.60 per cent. Smaller frames of 60 pounds or less are made from pig iron and scrap mixtures. Silicon is allowed to run over 2 per cent if strength requirements are not too exacting. Bearings show a higher carbon, approximately 3.43 per cent, and a higher phosphorus content than frames.

Heavy duty castings are subdivided into four classes as follows: Hydraulic, flywheels, drums and chemical engineering equipment. Steel is used in practically all mixtures. Average proportions run higher in the flywheel and hydraulic press classes than in any other type. Silicon is lower than in any other group 0.85 to 1.30 per cent. Phosphorus is kept under 0.30 per cent in most cases. Total carbon generally is low. Sulphur runs over 0.10 per cent in four cases but apparently has no ill effect on transverse strength and deflection. High manganese pig iron generally is used where sulphur is inclined to be high.

Mixtures for automobile and cylinder castings are divided into four subdivisions which include general automobile, automobile cylinder blocks and heads, cylinders and manifolds. From the data submitted, it was found that mixtures using only coke, pig iron and cast iron scrap are confined to carburetors and pump cylinders. Proportions of steel vary, 10 per cent being used in cylinders and pistons in which compressed air is used; 20 per cent and up in heavy steam cylinders; 15 per cent in manifolds, cylinders and heads, and cylinder blocks weighing from 50 to 600 pounds contain 13 to 14 per cent steel. Large proportions of properly graded and highly restricted scrap were noted as giving especially high-quality iron for general automobile purposes.

Charges using either high proportions of steel, alloy pig iron or high grade scrap are used to produce gears. Average results on test bars from companies manufacturing that type casting is as follows; Transverse strength, 2670 pounds per square inch; deflection, 0.28 inches; brinell, 210; and tensile strength, 33,000 pounds per square inch. Physical properties of 16 mixtures presented by 11 firms are exceedingly uniform.

Under the heading hard wearing castings is included dies, chafing plates, pug knives, grinding machinery, plow points, moldboards, trolley wheels, etc. Mixtures for dies and pug knives contain alloy pig iron and the castings have a silicon content of 1.60 per cent. The mixture also is used for cylinders which requireu hard wearing surfaces. A softer iron is produced for molds for rubber tires and contains a higher pig iron and silicon content. Scrap to the extent of 60 to 70 per cent is used to secure hard wearing surfaces on the die shoes and grinding machinery. The type scrap incorporated in the mix included chilled wearing parts and cast iron car wheels. From 10 to 40 per cent steel is used in all types of hard wearing castings. It seems especially useful in plow points. Nickel and chromium were used in pug knives and locomotive shoes which are subject to abrasion. Metal for vises had a deflection of 0.27 to 0.30 inch.

Fluidity Is Necessary

Iron for pipe flanges is made from mixtures containing 55 per cent pig iron and 5 to 15 per cent steel. High scrap ratios, 60 to 80 per cent, are used by two firms for pressure castings. Steel is used widely in pipe and valves especially in the latter class. Pig iron is kept fairly constant around 50 per cent and any increases of steel in the mixture are made at the expense of other scrap. Small valves generally are made from a 50-50 per cent pig iron and scrap mixture. As the weight increases to over 20 pounds, steel is included in the mixture.

Miscellaneous hardware includes those castings which depend on appearance for their value such as electric motors, enamel ware, light hardware, meter castings, ornamental castings, etc. The need for fluid metal in castings of this type is indicated by the chemical composition. A large majority of mixtures used for castings weighing 10 pounds or less contain 50 per cent or over of pig iron. In cases where a high proportion of pig iron is not used, the mixtures carry 2.5 to 6 per cent steel. Fairly high phosphorus pig irons, containing about 0.4 per cent phosphorus, for the entire pig iron constituent of the mix or high phosphorus irons containing from 0.8 to 1.0 per cent phosphorus in amounts up to 20 per cent of the total mixture are common. Soft irons with deflections of 0.26 to 0.30 inches result where the phosphorus does exceed 0.50 per cent. Sulphur is under 0.10 per cent in those mixtures and ferromanganese is not used. Brinell reading is around 180.

Iron for pumps is made from pig irons that are low in phosphorus and produce a soft iron with 157 to 187 brinell. Fractures do not indicate an open grain. Where higher proportions of scrap than 50 per cent are used, foreign scrap such as No. 1 machinery or automobile is incorporated.

Use High Pig Iron

Stove and furnace castings such as grate bars, furnace parts, stoker parts, and stove plate generally are made from mixtures containing 40 per cent or more pig iron. Silicon is in the 1.60 to 1.80 per cent range and ladle additions of ferromanganese and nickel are used in some cases. Mixtures for boiler sections and fire pots all contain 50 to 55 per cent pig iron and silicon in the metal ranges 50 per cent higher than in grate bars. Phosphorus does not run over 0.45 per cent and sulphur is below 0.10 per cent. Stoker parts contain silicon in intermediate percentages.

Silicon content of municipal castings runs between 2.10 and 2.30 per cent. Large amounts of scrap are used without any indicated uniformity in kind. Small percentages of steel are incorporated in that class of castings and higher ratios exist in castings with sections as high as 3 inches. Brinell hardness is uniformly high.

Most of the mixtures listed under the heading miscellaneous also appear under another heading. However, all mixtures listed as general jobbing contain from 45 to 60 per cent pig iron. Silicon varies from 1.55 to 2.45 per cent and phosphorus from 0.20 to 0.80 per cent. Those elements generally vary inversely. Most mixtures contain approximately 0.60 per cent manganese. One mixture containing 20 per cent steel is used to make piston ring pots and shows the highest deflection of all the bars tested. The mixture contains approximately 1.60 per cent silicon and 0.25 per cent phosphorus with sulphur around 0.10 per cent. Low proportions of scrap are used in that mixture. Mold and packing tube castings contain large quantities of

heavy scrap such as car wheels and other railroad scrap.

Included in the report are tables giving such information as mixture used, probable calculated composition, transverse strength in pounds on 18-inch centers, deflection, modulus of rupture, type fracture, brinell hardness, and range of thickness of castings and average weight. Another series of tables gives the average properties of each class of castings arranged in order of decreasing transverse strengths.

Reader's Comment

EDITOR'S NOTE—*Material Appearing Under This Head Does Not Necessarily Reflect the Opinion of* THE FOUNDRY *or of Its Editors.*

Outline Effect on Costs

TO THE EDITORS:

With reference to your questionnaire on foundry costs, in all cases the answer to No. 1 would be an increase of 45 cents per ton on castings with an increase of $1 per gross ton on pig iron.

No. 2—17 cents per ton.

No. 3—Our work practically being on piece work, we cannot get an exact answer, but the writer figures that a dollar a day would raise the cost of castings $2 per ton.

No. 4—In the first group we would figure from 600 to 1000 pounds; in the second group, 800 to 1500 pounds a day. We have had no experience with the heavy castings.

No. 5—The answer to this is variable depending upon the class of castings. The average weight of our castings would be from 6 to 7 pounds each, but the percentage of good castings to the melt ranges from 65 to 80 per cent. We have some extreme cases where the gate and sprue contain considerable more iron than the net castings.

L. C. HIRSHHEIMER
President

L. C. Hirshheimer, Inc.
La Crosse, Wis.

Production Per Man Increases

TO THE EDITORS:

On page 44 of the March 15 issue of THE FOUNDRY, you have a sketch of a balance on which you show lower labor off-set by lower efficiency.

In the experience of the writer, that has not been found to be the case. In those depressions he has known since 1910 where labor costs are lower than during the previous inflation periods, labor has shown greater efficiency. Production per man has always increased in times of depression.

Of course if you refer to lower efficiency due to the fact that shops are not operating a fair percentage of normal, therefore the men are not producing efficiently due to intermittent working days or periods, you would be correct.

The point I am trying to bring out is, that the lower labor in itself does not bring lower efficiency. I believe, however, that the reverse is true, higher cost of labor brings less efficiency, at least that is the experience in the shops that I have watched regarding labor costs.

I do not take exceptions to the ideas as explained in this article, but I felt that I would like to give you my thoughts regarding the labor cost and efficiency comparisons.

WALTER L. SEELBACH
Secretary and Treasurer

The Forest City Foundries Co.
Cleveland.

Gives Experience With Sand

TO THE EDITORS:

Some years ago we received an inquiry from you asking for a suggestion of what, in our opinion, would contribute to the value and interest of THE FOUNDRY. The writer replied that the addition of a *Foundry Forum* to your many other excellent features undoubtedly would be interesting. We note, with no little gratification, that you are now leading in that direction.

Now, don't all shout at once the familiar refrain—"Officer, he's in again"—well, we're in all right, so here goes: Replying to an inquiry on monel in the issue of March 1, Brother Vickers states that "one foundryman prefers to use a facing composed of 2 parts No. 2 Albany to 1 of Jersey fire sand wet down with a solution of 1 to 30 molasses water." He may or may not have had the writer in mind but, at any rate, your humble servant did express such a preference some time ago. Considerable aqua has flown 'neath the bridge since then.

Having carried on an intensive study of the many problems encountered on monel, covering a period of 10 years or more, we found occasion to modify our opinions—more or less—from time to time. Our final (?) conclusion on facing for medium work suggests 1 part silica to 2 parts No. 2 Albany sand with the addition of about 5 per cent ground clay, all mixed, sieved and wet down with molasses water after which it is put through a No. 2 riddle. We question the advisability of so much new sand in the facing when, in view of it being wet down with molasses water, a little clay will suffice.

Considering the way the molds and metal are handled—we ram firmly, spray lightly with molasses water, dust with silica flour and dry to a light brown—we have little trouble producing sound castings. An improvised, though efficient, burner is made from a 3-foot length of ⅜-inch pipe crooked and capped on burner end and ⅛-inch hold drilled in cap. We connect to pipe line with suitable length of hose.

Admitting that silicon is a moderate deoxidizer, we nevertheless contend that the small amount suggested (one-tenth of one per cent) is entirely inadequate. Prolonged experimenting has convinced the writer that magnesium, when properly handled, is the ideal deoxidizer for this metal. One or one and one-half per cent silicon is employed as a fluidizer thus permitting of a much lower pouring temperature with its consequent manifold benefits. But, one precaution—if you introduce more than 25 per cent remelt (gates, risers, defectives, etc.) you—well, you're out of luck. That, at least, sums up our experience.

RICHARD J. WALKER

Brooklyn, N. Y.

Seek Specifications for Cast Iron Pipe

Unification of specifications for cast iron pipe including materials, dimensions; pressure rating, methods of manufacture, elimination of unnecessary sizes and varieties; consideration of the possibility of developing a co-ordinated scheme of metallic pipe and fittings applicable to all common mediums and methods of making joints, is under consideration by a committee of the American Standards association appointed in 1926. Those types of castings covered by the work of the committee include bell and spigot pipe; flanged pipe; flanged and bell mouth fitttings and wall castings; pipe elbows, tees, Ys, return bends, and other fittings not now included in standard lists. Thomas H. Wiggin, construction engineer, Federal Water Service Corp., New York, is chairman and N. F. S. Russell, president, U. S. Pipe & Foundry Co., Burlington, N. J., is vice chairman. The project is sponsored by the American Water Works association, New England Water Works association, American Gas association and American Society for Testing Materials. Soil pipe is not included in the present project.

Larry J. Barton, specialist on the electric furnace for iron, steel and alloy castings, has opened an office as consulting metallurgical engineer at 19 Crystal Springs road, San Mateo, Calif.

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Figure Casting Loss

What percentage of castings is considered a normal loss in a gray iron foundry melting about 5 tons of iron per day in a 30-inch cupola. The castings may be listed as general machinery castings showing an average weight of 50 pounds. Most of these castings, gears, cams, slides, etc., are machined and must show a spotless surface.

This question might be answered briefly by the bare statement: 5 per cent. However, conditions vary to such an extent in different foundries that a high record in one, might represent a comparatively low record in another. Friction between the machine shop and foundry is the most prolific cause of high casting loss. In many cases castings are rejected by the machine shop, for minor imperfections that do not detract either from their appearance or utility. In other instances castings are rejected, because their acceptance might entail a little added expense in the machine shop. The ideal arrangement is one where a third person, responsible for the operation of both shops, has the opportunity of deciding whether a debatable casting should be reclaimed or scrapped.

The equipment, materials and personnel, factors in many instances over which the foreman has no control, exert an influence on the casting loss and must be taken into account in any impartial appraisal. Manifestly the same high degree of perfection can not be expected in one shop where these items are not maintained on the same high plane as in another foundry. For example, poor flasks are conducive to runouts, swells, strains and warped castings. Unsuitable sand and inferior blacking will cause scabs and roughness. Men with little or no molding experience will turn out more wasters than men who are highly skilled.

Under normal operating conditions the average general jobbing gray iron foundry is considered fairly efficient if the loss in defective castings is kept in the vicinity of 5 per cent. This subject, including a discussion of the total loss, that is the difference between the yield of good castings and the amount of metal charged in the cupola, was touched upon in "Prevent Losses with Proper Gates and Risers" which appeared in the Feb. 1, issue of THE FOUNDRY

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

Q & A

Iron Is Chilled

Do you know of any treatment for cores that will prevent cast iron from chilling when poured against them.

If you are referring to sand cores, we know of no treatment necessary because a sand core will not impart a chill to the adjoining metal. If you have reference to a metal core, we know of no coating material that will prevent it from imparting a chill to the metal that comes in contact with it, provided of course, that the metal is within the carbon-silicon range to take a *chill* in a given thickness of metal section. For example, a metal core will impart a deep chill to a casting ½-inch thick and with a silicon content of less than 1.00 per cent. The same core might close the grain to some extent, but it would not exert the least chilling effect on a casting 6 inches thick and with a silicon content of over 2.00 per cent.

Q & A

Sulphur Is Not High

We are having difficulty in keeping the sulphur in our castings down to the desired point, namely 0.06 to 0.08 per cent. Our mixture consists of 25 per cent pig iron containing: 2.05 per cent silicon; 0.029 per cent sulphur; 0.49 per cent phosphorus, and 0.84 per cent manganese—25 per cent pig iron containing: 2.10 per cent silicon; 0.025 per cent sulphur; 0.52 per cent phosphorus, and 0.90 per cent manganese —25 per cent return scrap containing: 2.14 per cent silicon; 0.113 per cent sulphur; 0.488 phosphorus, and 0.64 per cent manganese—and 25 per cent purchased scrap containing: 2.25 per cent silicon; 0.10 per cent sulphur; 0.50 per cent phosphorus, and 0.65 per cent manganese. By-product coke containing about 92 per cent carbon and under 1.0 per cent sulphur is used in a 42-inch inside diameter cupola with continuous tuyeres set 12 inches above the sand bottom. The tuyere has 6 openings at the shell 5 x 11 inches. Air is being supplied tangentially at the rate of 3322 cubic feet per minute. Coke in the bed is 33 inches above the tops of the tuyeres. Iron charges with 200-pound coke splits between give white-hot, clean metal, but the sulphur ranges from 0.10 to 0.12 per cent. How can we reduce it to about 0.07 per cent?

It is not necessary, except in rare cases, to keep the sulphur in gray iron down to 0.06 to 0.07 per cent, as up to 0.10 or 0.12 per cent usually is beneficial rather than otherwise. Two methods are open to you if you really

feel that it is necessary that the sulphur be reduced. First reduce the sulphur content of your metal charges by removing most of the purchased scrap and substitute steel scrap for it. Steel contains considerably less sulphur than your purchased scrap, but you will have to use pig iron with a much higher silicon content to compensate for that contained in the gray iron scrap. Second, use a lower sulphur content coke, say containing 0.70 per cent maximum rather than the 1.0 per cent grade you now are using. Also be generous in the use of limestone flux in the cupola.

The practice mentioned with coke containing about 0.50 per cent sulphur has been employed, and the resultant iron contained approximately 0.07 per cent sulphur. Sulphur in the iron may be lowered by using fused soda ash flux in the ladle or in a forehearth on the cupola. Several of those fluxes are on the market.

Q & A

Use Plated Patterns

I am thinking of starting a small foundry for the manufacture of hot air furnaces, but since I am not familiar with this class of casting I shall appreciate your opinion on the following points: 1—*Is it practical to use plate patterns for castings such as domes, ash pits, fire pots and bottoms?* 2—*Do you advise cast iron flasks, wood flasks with iron bars or all wood flasks?* 3—*What grade of sand is most suitable for these castings?* 4—*What weight should a molder put up in an 8-hour day if his sand is cut over for him in the morning? In other words how many hours would a molder require to make all the castings in a 600-pound furnace?*

Taking your questions in the order of presentation it is not only practical to use plated patterns on furnace castings, but it is the almost universal custom. The great bulk of these castings now are made on machines of various types by semiskilled men.

In the past, wood flasks have been employed in furnace shops and probably will serve your purpose where all the lifting has to be done by hand and where the production will be limited. However they are distorted easily, require constant care, and wear out rapidly. In some instances iron bars are required to insure the necessary rigidity, while in others long steel bolts extending from side to side serve the same purpose. Cast iron, cast steel, malleable iron and fabricated steel flasks are employed in all modern shops.

Any sand suitable for molding light machinery castings will serve satisfactorily on furnace castings. Every sand producer has his own method of grading the sand in his deposits. Also it is pertinent to point out that sands from various sections of the country, differing to a considerable extent in chemical analysis and physical properties, produce similar castings.

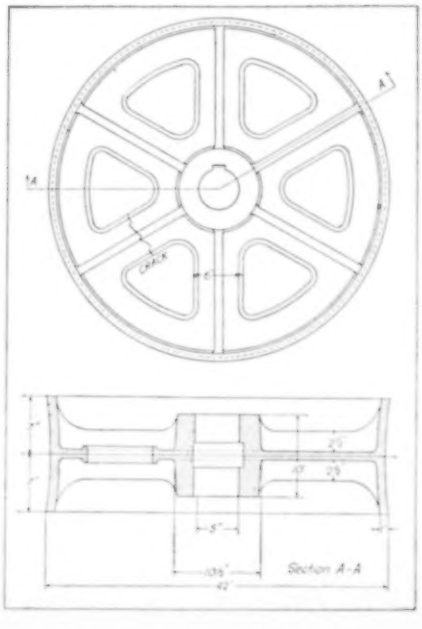
Under present conditions we know of no instance where a single molder makes all the castings in a furnace. The work is divided among a small or great number of men, depending on the size of the shop. Each man works on a single pattern. Thus one man makes nothing but fire pots, another specializes in domes, another in bottom rings and so on. The output per man ranges from 300 to 1000 pounds per day, depending on the character of the pattern and the extent of mechanical equipment.

GRAY IRON

Pulley Cracks in Web

We are forwarding blueprint of a friction pulley 42 inches diameter, 14-inch face, weight 1365 pounds which is causing trouble by cracking in the web. We use southern pig iron of the following analysis: Silicon 2.24 per cent, sulphur 0.027 per cent, phosphorus 0.58 per cent and manganese 0.63 per cent. Our scrap runs about 20 per cent auto scrap, 30 per cent light machinery scrap, 20 per cent heavy machinery scrap and 30 per cent shop scrap.

From the foregoing we presume that the total amount of scrap in the charge is made up in the proportion outlined, that is each 1000 pounds of scrap contains 200 pounds auto scrap, 300 pounds light machinery scrap, 200 pounds heavy machinery scrap and 300 pounds shop scrap. However, you do not give the amount of pig iron in each charge, therefore we are at a loss to estimate the approximate analysis of the iron in the casting. Assuming that you are using a half and half mixture, that is half pig and half scrap, the approximate silicon content in the casting would be 2.00 per cent. That is about as low as it is practical to carry the silicon in a casting of this shape and size. If you are carrying a heavier burden of scrap, say 60 or 70 per cent, the silicon content will be reduced below the 2.00 per cent mark, the manganese also will be decreased to a considerable extent and the sulphur content will show an increase. In other words, with every increase in the scrap burden, the desirable and strength giving elements will decrease, and the undesirable elements will increase.



Uniform Cooling Is Needed

On account of the wear on the face of this pulley, it is natural to want to make the casting as hard as possible—within reason. However, you must bear in mind that an increase in hardness usually means a decrease in elasticity. The casting shown in the illustration falls in that class which presents a problem in contraction and which invariably cracks unless preventative or remedial measures are employed before or after the metal is poured. Preventative measures involve the use of an iron that will stretch or give. The remedial measure usually takes the form of accelerated cooling of certain parts of the casting. In extreme cases it may be necessary to employ both measures. In the present instance the remedial measure may be sufficient. After the castings has set, dig out the center core and thus promote the uniform cooling of the hub and the rim.

Q & A

Manganese Is Low

What is purported to be the best analysis for annealing pots for malleable cast iron? We make pots for our own use, but opinions in our plant seem to vary as to the best iron to be used. Do you believe that the manganese content should bear any relation to the percentage of sulphur?

Iron used for annealing pots usually contain less than 1 per cent silicon, low manganese and high sulphur. An average composition will contain about 0.65 per cent silicon; 0.20 per cent manganese; sulphur around 0.200 per cent; phosphorus, 0.20 per cent, and total carbon held to a minimum by addition of high percentages of steel scrap. You have answered your own question as to the best analysis because opinions in the field vary as much as in your own plant.

One firm making pots used a charge composed of 1250 pounds of gates and return scrap; 200 pounds of malleable scrap; 300 pounds of steel scrap, and 250 pounds of pig iron containing about 2.75 per cent silicon, and 0.60 per cent phosphorus. Depending somewhat on the composition of the various types of scrap used, the final analysis of the

mixture will show around 0.65 per cent silicon.

Apparently, many malleable men favor a ratio of manganese to sulphur in pots which is just the reverse of that for the malleable cast iron, that is to say the sulphur content should be considerably higher than the manganese content. With the sulphur considerably higher than the manganese, it is claimed that less growth and deterioration will occur in the pots under the action of the annealing temperatures.

Q & A

Do Not Use Frozen Sand

We are operating a foundry in the Northwest, and during the severe winter weather the molding sand both in the heaps and the molds, freezes. Sometimes molten metal is poured into frozen or partly frozen molds. To what extent would that practice affect the castings made?

Sand that is frozen or even partly frozen should not be used for making molds, because there is a possibility that blowholes may be formed at such points where frozen balls of sand will come in contact with molten metal or be close to the surface of the mold cavity. However, if the sand was in the proper condition before the mold was made, and then frozen say in standing overnight, or over the week end, you should have no difficulty in obtaining a good casting from the mold.

Q & A

Iron Is Not Rustproof

We are making castings for a bread dough mixer. The barrel is made of monel metal, but the ends and paddle are of cast iron. Between mixings the cast iron parts rust, although they are cleaned. We believe that there is an alloy that can be added to the iron which will allow it to be machined, but which will prevent rusting. Can you give us any suggestions on making the iron rustproof?

While some of the alloy types of gray iron resist corrosion better than the ordinary variety of cast iron, they are not rustproof. To attain that condition it will be necessary to incorporate at least 14 per cent chromium, and such iron would have to be produced in an electric furnace to keep the losses of chromium at the minimum point. An alloy iron containing about 20 per cent monel metal, and 6 per cent chromium undoubtedly will resist rust much better than your present metal. It is not rustproof, as it will rust in distilled water containing carbon dioxide and oxygen. The rust appears in spots and is not closely adherent. In tap water and under atmospheric exposure it apparently rusts but little. If the water is slightly alkaline there is little tendency for rust formation. If the casting skin is left on the alloy iron resists rust better than when the surface is machined.

The alloy iron mentioned is made by adding ingot monel metal to the iron charges and the chromium as ferrochromium is incorporated in the ladle. The iron must be melted hot so that the ferrochromium will be dissolved rapidly.

Q & A

Growth Is Not Large

We intend to make cylinder liners for small internal combustion engines. We can get castings that are close grained and that wear well. In addition to those properties we would like to get a gray iron that will not grow. Can you give us any information whereby we can obtain results desired?

To obtain a gray cast iron that will be practically free from growth it will be necessary to go to the austenitic type iron containing 15 per cent nickel or over. However, such iron is expensive due to the alloy cost. All gray irons grow to some extent, but low-carbon, close-grained gray irons of high density rarely show serious growth at temperatures below 900 degrees Fahr. We do not believe that iron in small internal combustion engines becomes that hot although the gases may get much hotter. White irons do not grow readily, but are out of the question for your purpose. Growth of gray iron is discussed in some detail in the Feb. 1, 1931 issue of THE FOUNDRY, on page 92.

MALLEABLE

Increase Impact Value

We understand that a process has been developed for treatment of malleable cast iron before galvanizing. Have you any information relating to that process?

A process such as you mention was developed and patented in 1925 by a firm producing malleable iron castings mainly for its own use. It had been found that at various times, that castings which had been galvanized became embrittled, and after considerable investigation, it was claimed that the embrittlement or low impact value resulted from the temperatures at which hot galvanizing and sherardizing are conducted. Further investigation showed that if the castings were subjected to higher temperatures, quenched, and then galvanized, that the impact values were not lowered, but increased.

The method consists of heat treating the malleable castings at 1200 degrees Fahr. in a rotating, cylindrical furnace about 20 feet long. The furnace is oil fired and the interior is lined with spiral ribs which convey the castings from one end of the furnace to the other where they are ejected into a bath of water heated to about 175 degrees Fahr. The furnace has a capacity of 2400 pounds of small castings per hour and is rotated slowly enough to allow the castings to attain the required temperature. The process was developed by the Ohio Brass Co., Mansfield, O., and it is claimed that embrittlement in castings which have been galvanized, may be removed by treatment as previously explained.

STEEL

Steel Penetrates Core

We are making steel castings from electric furnace metal which are 8 inches in diameter and 40 inches long. The castings have two cores ¾-inch square through the entire length. We have been using square steel tubing ¾-inch inside diameter with a wall thickness of 1/16-inch which was filled with various mixtures of core materials. Thus far we have not had satisfactory results in removing the cores after the castings are finished. Can you suggest any core mixture that will stand up under the conditions outlined, and which can be removed without difficulty after the castings cool? Also can you suggest a better expedient than the steel tubing for establishing the cored holes?

It is difficult to core a hole as small as ¾-inch square through a steel casting 8 inches in diameter without having the core get hard. The difficulty usually experienced is that the steel penetrates between the grains of sand, and forms a sort of steel and sand pudding stone, in which the sand grains are cemented together with steel. Such material contains as much as 50 per cent steel by analysis, and neither can be chipped out nor drilled out. A steel tube with a wall thickness of only 1/16-inch is not sufficient to protect the core from steel penetration.

The usual means adopted for taking care of such a condition is to close up the grain of the sand by mixing it with a suitable amount of silica flour, and to give the core a heavy coat of silica wash to make the surface impervious to penetration. We suggest a mixture of 100 quarts of sharp core sand and 5 quarts of silica flour. Bind the mixture with 2½ quarts of linseed-base core oil of the best quality, and bake unwashed. After removing from the oven and while still hot, the core should be washed with 3 or 4 coats of a mixture of silica flour and oil binder about the consistency of the regular wash. The core then should be returned to the oven until the wash is dried thoroughly. The operation should be repeated 3 or 4 times to obtain a good adherent coating which will be practically impervious to metal penetration.

The FOUNDRY Family Photograph Album

Upper Left

P. R. HALL

Pennsylvania State College, State College, Pa.

Upper Right

H. M. MILLER

American Monorail Co., Cleveland

Lower Left

R. G. PARKER

Youngstown Foundry & Machine Co., Youngstown, O.

Lower Right

G. R. CASEY

Treadwell Engineering Co., Easton, Pa.

TENTATIVE SPECIFICATIONS FOR

ALUMINUM-BASE ALLOY CASTINGS

This is a tentative standard, published for the purpose of eliciting criticism and suggestions, and as such is subject to annual revision.

Issued, 1924; Revised, 1925, 1926, 1930

These specifications cover commercial aluminum-base alloy castings having a specific gravity of three and less. Eleven alloys are specified and are designated Alloys *A* to *K*, inclusive (see Note 1).

MANUFACTURE

The alloy may be made by any approved method.

CHEMICAL COMPOSITION AND TESTS

The alloys shall conform to the requirements as to chemical composition specified in Table I (see Note 1).

Table I

COMPOSITIONS OF ALUMINUM-BASE ALLOY CASTINGS

Alloy	Aluminum, per cent	Copper, per cent	Iron, per cent	Silicon, per cent	Magnesium per cent	Manganese, maximum per cent	Zinc, maximum per cent	Other Impurities, maximum per cent
A	Remainder	7 to 8.5	1.2 max.	0.5 max.	trace	0.3	0.2	0.3
	Alloy A—Total of all constituents other than aluminum and copper not to exceed 1.7 per cent.							
B	Remainder	7 to 8.5	0.8 to 1.4	1 to 1.5	trace	0.3	0.2	0.3
C	Remainder	6 to 8	1.5 max.	1 max.	...	...	2.5	1
D	Remainder	6 to 8	1.2 max.	2 to 3	...	...	1.5	0.5
E	Remainder	11 to 13	1.2 max.	1 max.	trace	0.3	0.2	0.3
F	Remainder	9.25 to 10.75	1.5 max.	...	0.15 to 0.35	0.2	0.2	...
	Alloy F—Iron plus silicon not to exceed 2 per cent.							
G	Remainder	4 to 5	1.2 max.	1.2 max.	0.3 max.	0.3	0.2	0.2
	Alloy G—Total of all constituents other than aluminum and copper not to exceed 2.5 per cent.							
H	Remainder	3.5 to 4.5	1 max.	0.7 max.	1.2 to 1.7	...	0.1	0.2
	Alloy H—Nickel 1.8 to 2.3 per cent.							
I	Remainder	0.6 max.	1 max.	4.5 to 6	trace	0.3	0.2	0.3
J	Remainder	0.3 max.	0.8 max.	12 to 13	trace	0.5	0.2	0.3
K	88 min.	3 to 4	1 max.	7 to 9	trace	0.3	0.2	0.3

(a) The sample for chemical anaylsis may be taken either by sawing, drilling or milling the casting or tension test specimen and shall represent the average cross-section of the piece.

(b) The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation, and the sawings or metal chips shall be carefully treated with a magnet to remove any particles of iron introduced in taking the sample.

Abstracted from the American Society for Testing Materials *Tentative Standards*, 1930.

(*Continued on Data Sheet No.* 860)

TENTATIVE SPECIFICATIONS FOR

ALUMINUM-BASE ALLOY CASTINGS

(*Continued from Data Sheet No.* 859)

PHYSICAL PROPERTIES AND TESTS

The alloys shall conform to the minimum requirements as to tensile properties specified in Table II (see Note 2).

(a) Two test bars shall be an integral part of large castings, or cast separately in the case of small castings to represent a lot or melt, and shall be molded in a manner similar to the castings which they represent. If the castings are heat treated, the test bars representing such castings shall be similarly heat treated.

(b) The manufacturer and purchaser shall agree whether the test bars can be attached to castings, on the locations of the bars, on the castings to which bars are to be attached, on the method of casting unattached bars and whether a *cast-to-size bar* or a *machined-to-size* bar shall be used (see Note 2).

Table II

PROPERTIES OF ALUMINUM-BASE ALLOY CASTINGS

Alloy	Tensile Strength Minimum Lb. per Sq. In.	Elongation in 2 In., Minimum, Per Cent
A	18,000	...
B	19,000	...
C	19,000	...
D	18,000	...
E	19,000	...
F	19,000	...
G Heat Treatment No. 1[a]	28,000	6
G Heat Treatment No. 2[a]	30,000	3
G Heat Treatment No. 3[a]	36,000	0
H Heat Treated[b]	32,000	...
I	16,000	3
J	24,000	5
K	...	...

a See Note 1, Alloy G.
b See Note 1, Alloy H.

(c) The *machined-to-size* bar shall be cast according to the dimensions shown in Fig. 1, and machined to conform to the dimensions shown in Fig. 2. The *cast-to-size* bar shall be cast according to the dimensions shown in Fig. 2 and shall be tested without machining. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial (see Note 3).

(a) Tests as far as possible shall be made by heats or melts, but unless otherwise agreed upon, two tension tests shall be made upon each unit lot of 500 pounds or single delivery of less than 500 pounds.

(*Continued on Data Sheet No.* 861)

THE FOUNDRY DATA SHEET, MAY 1, 1931

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Problems in Nonferrous Founding

By Charles Vickers

Venting Is Necessary

We are making bronze bushings approximately 22 inches diameter, with 1¼ inches metal section and 5 feet long. They weigh around 1400 pounds and as they are machined all over, the castings must be perfect. Our difficulty is that they develop blowholes on the cope side, occurring somewhere in a band along the top about one-fifth of the circumference of the casting. The metal composition is 71 per cent copper; 7 per cent tin; 22 per cent lead, made from the following mix: 15 per cent shop scrap, same composition; 19 per cent lead; 6 per cent Straights tin and 60 per cent virgin copper.

About 80 per cent of the metal is melted in a rocking electric furnace. The remainder is melted in an oil-fired tilting crucible furnace. About 1 ounce of phosphor copper is added per 100 pounds. The metal is tapped from the furnace into a 300-pound crucible and transferred to a 2000-pound brick-lined, graphite-washed pouring ladle. The metal is stirred thoroughly with an iron bar. It is tapped at 2150 degrees Fahr., and poured into the large bushings at 1900 degrees Fahr. The mold is made of an open sand, thoroughly dried in the oven. The core is also of open sand, composed of 6 parts torpedo sand; or washed gravel, as used in concrete, 2 parts of molding sand and cereal binder 1 to 25. The core is made in halves, with a 6-inch vent opening, and plenty of coke in the body of the core. It is not blackened after leaving the oven. The core comes out of the casting freely. Cores made of an open oil-sand were tried with no better results. The mold is tilted about 6 inches, and poured through one end through a common runner box leading in to a sprue on either side of the casting. Three risers are located along the top, and after the mold is filled about 100 pounds of extra metal is washed through. Before machining the castings look perfect. Ninety per cent turn out good in the bore but show holes on the outside after machining.

From the description of the manner in which this mold is made it undoubtedly is made by molders worthy of the name, and that the trouble of the air holes is caused by some little thing, in itself insignificant, but none the less costly. A study of the mold as it lies on the floor ready for the metal, is suggested and the question to ask is: Why is it that the air catches in that same belt in the cope? The mold is filled with air before pouring is commenced, and if the metal can pocket it anywhere as it gradually fills the mold, it will catch there. A pot riser on the pocket ought to let the air out. Therefore, it may be advisable to place a riser over the point where the blows occur and see whether it will eliminate the difficulty. It may be the mold is tilted too much and that point should be considered. It hardly seems possible that with the mold tilted 6 inches in 5 feet or approximately 6 degrees, difficulty should occur. However, it may be worth while to reduce the angle to see what effect, if any, is obtained.

Another important thing: Does air enter the mold with the metal? Is the runner box immediately filled, and kept filled, as long as the mold takes metal? A falling stream will carry down air and discharge it at the bottom into the casting. The sprue must be filled all the time a large casting is taking metal, otherwise air is blown into the mold, and some of it is sure to get caught. It is necessary that the sprues or the runner box are kept filled with metal. If your gates take metal faster than it can be poured they are too big; make them smaller. Brass does not need big gates; and make the sprue so that it can be kept filled.

Use a flux on the alloy composed of 85 per cent plaster of paris; 10 per cent soda ash and 5 per cent borax. The latter should be anhydrous, that is calcined. Use 2 per cent of the flux in melting the metal. While 1900 degrees Fahr., may be a suitable pouring temperature for the alloy, highly leaded alloys should be brought to at least 2200 degrees in the furnace. We hesitate to advise the addition of more phosphorus, because its tendency is to drop the lead, but if you think it would stand 0.25 per cent phosphor-copper, it would be better for that alloy.

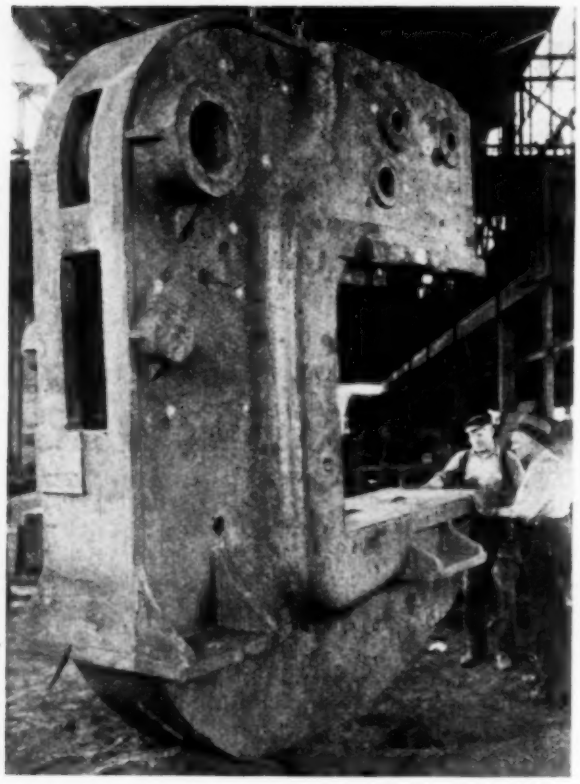
Cupola Melts Bronze

Is it possible for us to melt 85-5-5-5 alloy ingots in our cupola? The latter is 48 inches in diameter and the blast pressure 9 ounces. We would like to melt 1 or 2 tons if the process is feasible, and would like to have information on melting in that manner.

Cupolas have been used in the past for melting brass, and at the present time several small units are in operation. These units are about 22 inches in diameter and melt a charge of 500 pounds in about 10 minutes. A special coke with a low sulphur content is claimed to be used for the fuel. In a 48-inch cupola the usual iron charge is 2000 pounds, but in the case of melting bronze, we suggest 1000-pound charges. Jennings in a paper on melting copper in a cupola placed protective coverings of charcoal between the metal and the coke, and you may find it advantageous to do the same.

Put in the bed in your cupola the same as for melting iron which probably will extend 30 inches above the tops of the tuyeres. Then put on a layer of charcoal that will cover the coke evenly. Place the first metal charge of 1000 pounds evenly over the charcoal and then cover with a layer of charcoal. Follow with the first coke split of say 60 pounds, a layer of charcoal, the metal charge, and so on until you have charged the desired amount. It is desirable to use a flux when melting in the cupola, and it is suggested that you use fused soda ash which may be purchased in brick form for the purpose.

Preheat the ladle or ladles to a good red heat so that there is little loss of heat when the metal is tapped into them. Have a layer of glowing charcoal on the bottom of the ladle. The metal from the cupola probably will be too hot to pour, so let it stand in the ladle until the pouring temperature is right for the work. That will give any gases which were absorbed, a chance to escape. There will be a loss of zinc in cupola melting, and you will have to make some analyses to determine the loss. The additional zinc to make up for that lost, is added in the ladle. The added zinc should be stirred in well to insure thorough and complete mixing.



Indirect Heat *Utilized* *in* Dual Purpose Oven

By J. B. Nealey

Fig. 1—Large and Small Castings Are Produced

PROBLEMS of core baking and mold drying are of interest to the management of many foundries. Various types of ovens are used in baking and drying, including those which are direct fired, and others, more recently introduced, using the indirect, recirculation method. An installation of that type is used in the foundry of the Hansell-Elcock Co., Chicago, which produces castings ranging in weight from a few ounces up to more than 30 tons. The company carries on a general jobbing business which includes the manufacture of ornamental iron, lamp posts, sewerage fittings, flag pole bases, heavy machinery bases and housings, etc. A structural steel shop also is maintained. The foundry is housed in a building, 480 feet long and 100 feet wide, with glass sides and an inverted roof.

A railroad spur runs along the South side of the building and is served by a crane with a 75 foot span and 450 foot runway. Magnets and clam shell buckets are used to handle raw materials which are stored in a line of bins parallel with the tracks. Coke is received in dump bottom cars and is carried by belt conveyors and bucket elevators to storage hoppers over the loading platform of the cupolas. Two cupolas are used and they are charged in the usual manner.

Spanning the main bay, is a crane runway 52 feet wide running the entire length of the building. That section of the foundry is served by three cranes with capacities of 5, 10 and 20 tons. A group of jolt roll over and plain jolt machines is located at the head of the main pouring floor. The south bay is 30 x 280 feet and is served by three, 3-ton hoists on motor operated cranes controlled from the floor. Two thirds of the space is used as a pouring floor and the remainder for core making. The north side is composed of two parallel bays, one 50 x 180 feet, equipped for bench molding and the other 30 x 180 feet, provided with machine molding units. Pouring floors occupy the remainder of the space. Those are served by three, 2-ton hoists mounted on hand operated cranes with a 28 foot span.

Insulation Is Heavy

A separate building, one side of which opens into the foundry, was built to house the combination core baking and mold drying oven. The lower part of the building is of brick but the upper is constructed of glass. The oven proper is 24 feet long, 22 feet wide and 14 feet high, inside dimensions. Walls are of brick, 2 feet thick with a 3-inch dead air space in the center. The roof consists of 4 inches of hollow tile and 10 inches of concrete. The door is of steel plate construction, filled with cork insulation, and is carried on steel supports 25 feet high.

Four tracks, for two cars and an extra rail for a single car in the center, are embedded in the concrete floor in the event the load spans the oven. Two concrete molding pits, one of which is 16 feet square and 9 feet deep, and the other 18 x 20 x 8 feet deep, are located near the entrance.

Hot air for baking and drying is forced into the oven through two sets of ducts, one of which is 12 x 14 inches in cross section and extends along the two sides and back walls, resting on the floor. Openings, 4 x 10 inches, in the ducts are spaced about 4 feet apart and are fitted with shutters, by which the volume and velocity of the hot air entering the oven can be regulated. The other duct is embedded in the floor and runs down the center of the oven for complete circulation.

The outlet duct is similar to the U-shaped inlet duct except that it is located on the ceiling of the oven and the space between the arms is not as great. A flue passes directly from the inlet ducts, upward to the heater fan while another extends from the outlet duct to the heater. The fan sucks hot air from the heater and again forces it into the inlet duct to the oven. Thus the air is recirculated with little loss in heat. Pressure amounting to ¾ of an inch of water is maintained in the oven.

The heater is 7 feet long and 4 feet square in cross section and is equipped with four gas burners located in one end. These burners have a total capacity of 3000 cubic feet of 535 B.t.u. gas hourly and fire through tunnels, directly into the heating chamber through which the air from the return duct is pulled to be reheated. Hot air then is pulled through the fan and forced into the

inlet duct. Additional air for atmospheric conditioning is pulled through openings in the burner setting and that air volume is controlled by an adjustable shutter. Air for combustion is entrained through the burner pipe.

Correct temperature is maintained automatically by a pyrometer connected to a two position, motor operated valve, in the gas supply line. When the temperature rises above a predetermined degree, the motor partly closes the valve and reduces the volume of gas being burned. As soon as the temperature has dropped the valve automatically opens to the full position.

A feature of this heater is a safety control damper in the heating chamber. That damper is balanced so that the fan sucking hot air from the duct will keep it in the open position. If the fan motor stops, the damper drops, preventing any more air from entering the heater and at the same time operates an arm which closes the valve in the gas supply line. When the motor again is started, the valve in the gas line opens automatically.

Two other core ovens of the car type, 24 feet long by 12 feet wide by 12 feet high, located side by side with a wall between and similar to those previously described, also are used for core baking and mold drying. Each is heated with a single heater of the same type as that previously mentioned but slightly smaller. They are fired with three, nozzle mixing, gas burners.

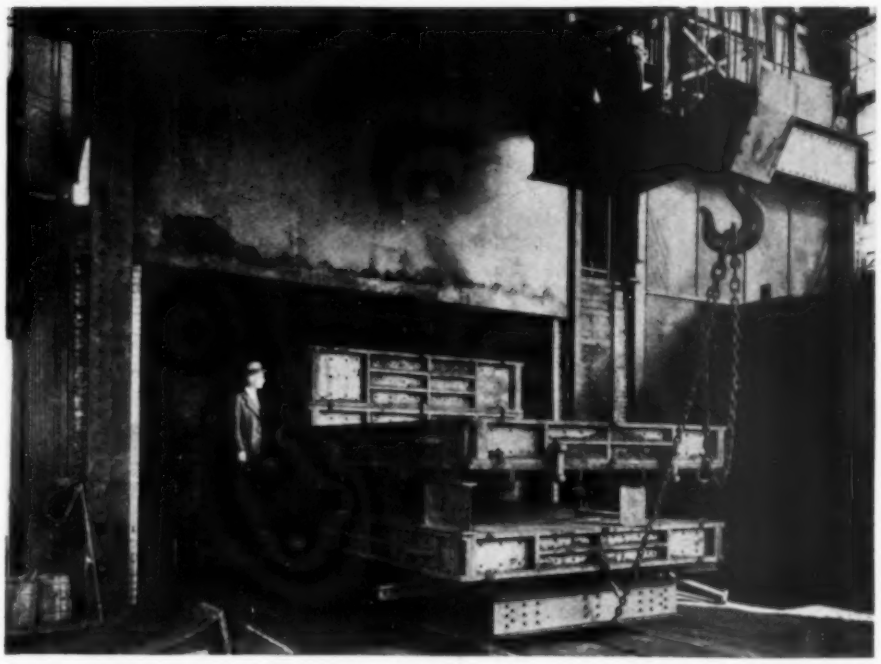


Fig. 2—Oven Has Brick Walls 2 Feet Thick with a 3-Inch Dead Air Space. The Roof Has 4 Inches of Hollow Tile and 10 Inches of Concrete

British Metallurgists Meet in London

The twenty-third annual general meeting of the British Institute of Metals was held in London on March 11 and 12 with the president, Dr. Richard Seligman, in the chair. In the report of the council for the past year, the secretary pointed out that the membership of the institute has increased from 2122 to 2160, and that the institute's financial position had been maintained during the period under review.

Following the reading of the report, the secretary announced that the officers of the council for the year 1931 had been elected as follows: President, Dr. Richard Seligman, Aluminum Plant & Vessel Co. Ltd., Wandsworth, London; vice presidents: W. R. Barclay, Henry Wiggin & Co. Ltd., Birmingham; Lt. Col. Sir Henry Fowler, London, Midland & Scottish railway; Dr. A. G. C. Gwyer, British Aluminum Co. Ltd., Warrington; Prof. D. Hanson, University of Birmingham; Dr. R. S. Hutton, British Nonferrous Metals Research association, and Engineer Vice-Admiral Sir Reginald W. Skelton, London.

Fourteen papers were presented to the meeting. L. J. Brice, Research department, Woolwich, contributed a paper entitled: "Some Properties of Silicon-Aluminum Bronzes," in which he described the results of a detailed study of the brinell hardness, mechanical properties, and microstructure of three typical aluminum-copper alloys, containing respectively 5.0, 7.25, and 10.0 per cent aluminum, with the addition to each of up to 5.0 per cent silicon. The alloys were examined in the chill-cast condition, and also after mechanical and heat-treatments.

Results of the author's experiments show that with 5.0 per cent aluminum, the addition of up to 2.0 per cent silicon improves the general properties. Further addition of silicon gives progressively increased hardness, but leads to reduced toughness and ductility, although considerable improvements can be effected by heat treatment. An annealed alloy containing 3.5 per cent silicon has properties comparable with those of a normal 10 per cent aluminum bronze. Ductility of the heat treated alloys although greatly reduced is not destroyed by the addition of up to 4.5 per cent silicon.

With 7.25 per cent aluminum, the addition of up to 4.0 per cent silicon gives progressively increased yield point and maximum stress and hardness, with decreased ductility and toughness. Good combination of properties is obtained with 1 per cent silicon, while with 2.86 per cent silicon the following may be obtained: Yield point, 44,800 pounds per square inch; maximum stress, 93,600 pounds per square inch; elongation,

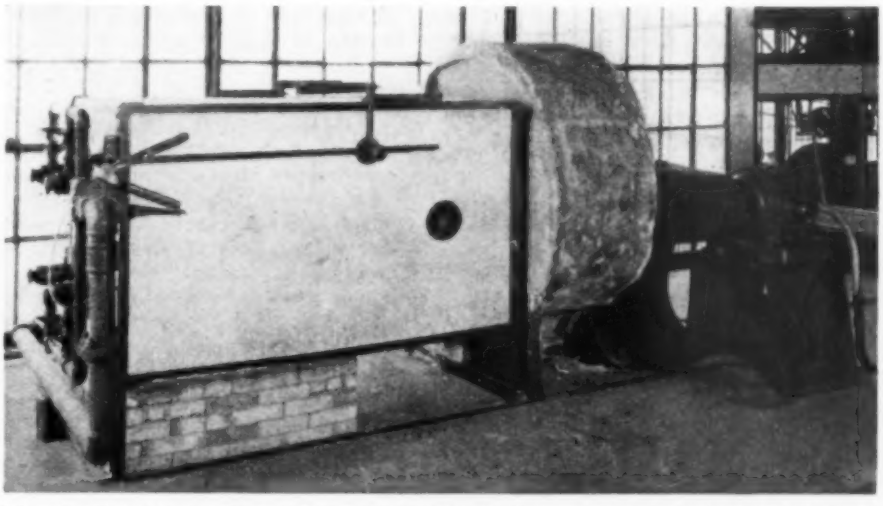


Fig. 3—Hot Air Is Recirculated Through the Oven. Gas Supplies the Heat to the Air

12.8 per cent on 1.265 inch; Izod impact figure, 16 foot-pounds; brinell hardness, 196. With more than 3.0 per cent silicon, the ductility and toughness of the alloys in all conditions are so low as to render them useless for practical purposes.

The paper by J. D. Grogan and D. Clayton, research assistants, National Physical Laboratory, Teddington, dealt with "Dimensional Stability of Heat-Treated Aluminum Alloys." Careful search effected by the authors has failed to reveal the occurrence of change over external periods in certain commercial heat-treated aluminum alloys, subsequent to the completion of the normal aging process. Serious dimensional changes occur when machining operation are carried out on material quenched in cold water. These changes are reduced to relatively small proportions in Y-alloy (aluminum, 92.5 per cent; copper, 4 per cent, magnesium, 1.5 per cent, and nickel, 2 per cent) and duralumin (aluminum, 95 per cent; copper, 4 per cent; manganese, 0.5 per cent and magnesium 0.5 per cent), the only alloys examined in this way, by the employment of boiling water as quenching medium. Cold cottonseed oil produces intermediate effects. These alloys, when quenched in boiling water(develop satisfactory mechanical properties. Other papers presented at the meeting included: "Investigation of the Effect of Impurities on Copper, Part VII—The Effect of Antimony, and Part VIII—The Combined Effect of Antimony and Arsenic," by S. L. Archbutt and W. E. Prytherch: "The Corrosion of Early Chinese Bronzes," by W. F. Collins; "Deformation of Metals under Prolonged Loading; Part I—Flow and Fracture of Aluminum," by Prof. D. Hanson, and "Solid Solutions of the Copper-silver System," by D. Stockdals. The annual May lecture of the British Institute of Metals will be delivered May 6 by W. B. Woodhouse, Yorkshire Electric Power Co., and will deal with the technical and economic progress in the generation of electric power on a large scale.

Testing Society Holds Regional Meeting

Nearly 700 members and guests attended the second regional meeting of the American Society for Testing Materials which was held at the William Penn hotel, Pittsburgh on March 18. Ten papers relating to the subject of welding were presented at the symposium which was held in conjunction with the Pittsburgh section of the American Welding society. These gave interesting data.

Several standing committees of the American Society for Testing Materials also met from March 18 to 20, and discussed problems relating to their work. Committee A-7 on malleable castings voted to recommend as a tentative standard a specification for higher strength iron conforming to the requirements of the American Railway association. A subcommittee in charge of an investigation on corrosion of malleable iron has been continued with authority to add new members for the purpose of securing authoritative data and correlating such data with information already at hand. The subcommittee in charge of specifications for automotive malleable castings was instructed to propose a report covering that industry's needs. Committee A-7 also authorized its chairman to take under consideration the advisability of sponsoring an investigation on embrittlement of malleable castings for uses in the galvanizing process.

Subcommittee II on cast metals and alloys of Committee B-5 on copper and copper alloys, wrought and cast, discussed in detail some possible revisions in the tentative specifications for copper-base alloys for sand castings. The possible revisions are to make the 15 alloy compositions covered by that specification more accurate and workable, and generally satisfactory to both producers and consumers. However, before taking final action on the revisions under consideration, the committee will submit those to the Nonferrous Ingot Metal institute which assisted in the development of the tentative specification. The committee also discussed the desirability of developing methods of chemical analysis for copper-base alloys in ingot form and consideration was given particularly to new methods of sampling ingot metals.

Committee A-3 on cast iron formed a new subcommittee on automotive castings under the chairmanship of A. L. Boegehold, General Motors Corp., Detroit, which will consider specifications and problems pertaining to automotive gray iron castings. A reorganization of one subcommittee has been effected to create a subcommittee on cast iron culvert pipe under the chairmanship of E. F. Kelly, United States bureau of roads. A new subcommittee has been formed to consolidate the work of the subcommmittees on general castings and high-test cast iron. The new subcommittee will attempt to work out a logical classification of gray iron castings, and devlop specifications accordingly. Considerable work has been done on the investigation of impact testing of cast iron, and it is expected that the results will be reported to the society in 1932. A proposed tentative method of sampling coke for analysis was presented for discussion by committee D-5 on coal and coke. However, it will not be recommended to the society as a tentative standard until it has been tested more thoroughly. Satisfactory progress was reported by various subcommittees on foundry coke specifications, sampling, tolerances, pulverizers, and on the test for agglutinating value of coal. The research committee on fatigue of metals after discussion decided to continue the practire of preparing annual abstracts of articles on fatigue of metals appearing in the various technical papers and society proceedings, both American and foreign and assigned members to cover that work for the period July 1, 1930 to June 30, 1931. About 75 important articles were abstracted during the year 1929 to 1930. The committee decided to start the preparation of a statement of the present day knowledge of the failure of metals under simultaneous action of repeated loading and corrosion, which is a serious problem. The committee also will prepare a statement of the significance of results of fatigue tests under repeated loading for structural engineers, machine designers, and makers and users of boilers, tanks, oil stills, and other pressure vessels.

National Safety council, 20 North Wacker drive, Chicago, has prepared a safe practice pamphlet for foundries entitled, "Cleaning and Finishing Rooms in Foundries." Single copies may be secured free.

Fig. 1—A View of One of the Molding Bays Showing the Overhead Tramrail System, and the Method of Transporting Castings to the Cleaning Department

Canadian Shop Controls Product

ONE of the largest and most modern bronze foundries in Canada is that of the Robert Mitchell Co. Ltd., St. Laurent, Que., which formerly was known as the National Bronze Co. Ltd. The foundry was constructed during 1929, and was placed in operation early in 1930. Approximately 30,000 pounds of castings are being produced a day. The foundry proper is about 200 feet long and 100 feet wide and is divided into five bays producing castings of varying sizes and weights. One bay is devoted to the production of heavy castings on molding machines. The next bay is used for the production of heavy castings which require hand molding on the floor. Small castings weighing from 1 to 10 pounds and made on the bench are molded in the third bay while the fourth bay is devoted to molding machine production on small castings. The fifth bay is used for the production of heavy castings weighing from 1000 to 10,000 pounds and is served by a 5-ton crane. Architectural bronze and statuary castings are produced in the latter bay.

Metal is melted in a battery of four indirect arc, rotating type furnaces supplied by the Detroit Electric Furnace Co., Detroit, and shown in Fig. 2. Two of the furnaces have capacities from 1000 to 2000 pounds, and the capacities of the other two range from 250 to 350 pounds. Those melting units are amplified by a battery of gas-fired crucible furnaces which are used for the production of special alloys, or small quantities of alloys. The gas-fired furnaces also are used as auxiliary units for the production of especially large castings. The combined capacity of both units will supply sufficient metal to pour a casting weighing 7500 pounds.

Raw Materials Segregated

Fig. 3 shows the metal bins which are located at the rear of the foundry. Each bin is numbered as may be observed, and contains a specific type of raw material. Particular care is taken to see that the various ingot metals such as copper, tin, aluminum and bronze, and the various types of scrap materials are placed in their proper bins. One of the features of the department is the traveling scale shown in the illustration. The man whose duty it is to supply the furnaces with metal is given a weight sheet which specifies the weight of each type of raw material by bin number. He pushes the scale in front of the various bins, weighs out the materials and checks each weight. When the complete charge is weighed, a final check is made on the weight, and the charge is conveyed to the furnace on an overhead tramrail system.

Sands used for molds and cores are stored in bins along the side of the foundry adjoining the railway siding. Various kinds of sands are used in the foundry. River sand for core making is obtained from the Ottawa river beds. Molding sands include that obtained from the Albany district, a special red sand imported from England and architectural molding sand from France. Molding and core sands are machine mixed before use. The molding sand is tested for moisture content, permeability and bond strength to insure that it is in

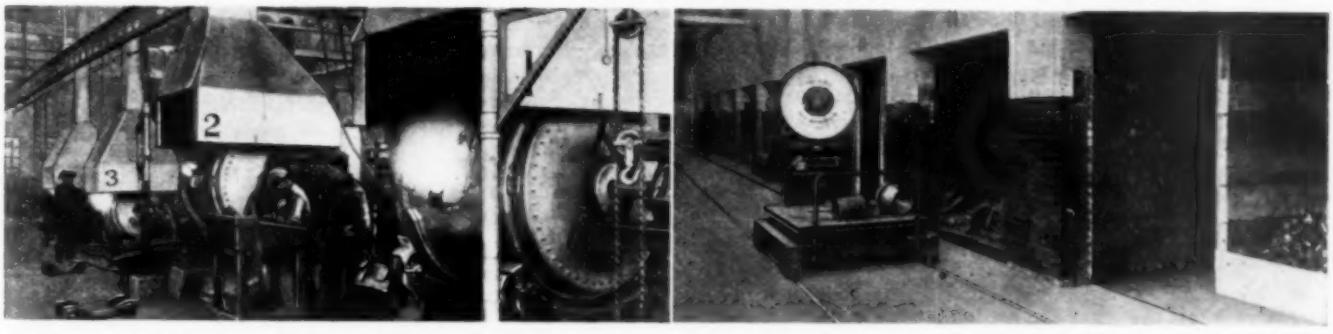


Fig. 2—Four Indirect Arc Type, Rotating Electric Furnaces of Different Capacities Melt the Bulk of the Metal. Fig. 3—Raw Materials Are Stored in Numbered Bins, and Weighed Out on a Traveling Scale Car

the proper condition for molding.

After the castings are shaken out from the sand, they are transported to the cleaning department on electric trucks. Some castings are taken to the sandblast room for cleaning while others are cleaned in tumbling barrels. When the castings are cleaned satisfactorily, they are taken to the grinding machines where any rough places on the castings are removed. Following a final inspection, the castings are taken to the shipping department.

One of the features of the foundry of the Robert Mitchell Co. Ltd. is the complete metallurgical control that is practiced. That includes chemical analysis of the raw materials, checking of the weights of materials entering the furnace charges, control of mold conditions through moisture, permeability and bond strength of the molding sands, close attention to core sand bonding materials and mixtures, checking of metal pouring temperatures with standardized pyrometers, etc. In addition to the plant control, a well equipped laboratory is maintained for conducting the necessary routine tests and research work. Finished castings often are fractured to see that chemical and physical determinations performed on test bars cast with each heat are reflected in the castings.

Maintain Testing Equipment

Equipment in the physical laboratory includes a machine for determining tensile and compressive strengths of the various alloys made by the firm. Auxiliary devices for the testing machine include an electric furnaces through which tests at elevated temperatures may be conducted, and apparatus for maintaining subzero temperatures. An impact testing machine of the Izod type is used to determine the impact or shock resisting qualities of the alloys. Hardness is determined on a brinell type tester while a metallurgical microscope of the latest type with camera attachment is employed for examining the microstructure and keeping a permanent record of the structure obtained under various conditions.

The Robert Mitchell Co. has given especial attention to the welfare of its employes, and has provided a spacious wash room which is fitted with sanitary wash basins and showers. Each employe has an individual locker for his clothes and personal belongings. In addition, a bright and airy cafeteria and lunchroom is maintained so that the employes may enjoy their noon-day meals amid pleasant surroundings.

Claus Greve, L. W. Greve and John DeMooy were named chairman of the board, president and treasurer respectively of the Cleveland Pneumatic Tool Co., Cleveland, at the annual meeting of the board.

Round Table Discussion Features Meeting

The regular monthly meeting of the Connecticut Nonferrous Foundrymen's association was held at the Hotel Garde, New Haven, Conn., April 13. The meeting was devoted to a round table discussion of nonferrous foundry problems. The discussion was led by Dave Tamor, metallurgist, Pratt & Cady division, Reading Steel Casting Co., Hartford, Conn., who was assisted by B. Stewart, Bridgeport Deoxidized Bronze Co., Bridgeport, Conn. The next meeting of the association will be held at the same location May 18. B. S. Schmehl, the Barrett Co., New York, will be the speaker and will discuss the fixed carbon fuel process for melting bronze and brass.

Publishes Brochure

Pittsburgh Testing Laboratories, Pittsburgh, celebrating the fiftieth anniversary, recently published a brochure in which the accomplishments and the progress is outlined. The first part of the booklet is devoted to the development and expansion of the company since its organization in 1881. The various services that the company renders also are described. The remainder of the brochure shows the facilities of the company both at the headquarters in Pittsburgh and at the various branches. The latter pages of the booklet outline the value of such services as the company renders to industry. The booklet is well illustrated with reproductions from photographs of many of the departments both in Pittsburgh and in branches.

Book Review

Engineering Metallurgy, by Bradley Stoughton and Allison Butts, cloth, 6 x 9 inches, 498 pages, 200 illustrations, published by the McGraw-Hill Book Co., 370 Seventh avenue, New York, and supplied by THE FOUNDRY for $4.00 plus 15 cents postage and in London by the Penton Publishing Co. Ltd., 116-17 Caxton House Westminster, for 20s postage extra.

This is the second edition of a book published under the same title in 1926. The authors have found that the rapid advance of metallurgy has necessitated additions to the text and rearrangement of the subject matter. Material included under the chapter on the theory of alloys has been increased and more data have been given on the heat treatment of alloys and alloy steels. A separate chapter has been devoted to welding and the text on testing and examination of metals has been rewritten.

The book is an excellent text for college and university students and is a valuable reference book for those interested in the fundamentals on both ferrous and nonferrous metallurgy. For those interested in the details of the various processes described, each chapter is appended with a bibliography of reference books and periodicals.

Text matter is divided into 18 chapters devoted to the following subjects: Introduction; metals and other materials of construction; testing and inspecting metallurgical products; ores and ore treatments; divisions of chemical metallurgy; sizing and shaping metallic bodies; welding and joining metallic bodies; theory of alloys; heat treatment and effect of heat treatment on metallic bodies; properties and uses of the ferrous metals, iron and steel; processes for producing and refining steel and their effect upon properties; properties and uses of common nonferrous metals; producing and refining nonferrous metals; corrosion and its prevention: fuels and combustion; pyrometry; metallurgical slags and fluxes; and refractories and heat losses in industrial furnaces.

Twin-City Group Hears Talk on Sand

The regular monthly meeting of the Twin-City Foundrymen's association was held April 15 at the Minneapolis Athletic club. The association has members from 27 foundries on its roll, of which 20 were represented at the meeting with a total attendance of 38. Harry W. Dietert, U. S. Radiator Corp., Detroit, was the speaker of the evening, discussing "Foundry Sand Losses." In addition to his talk, which was illustrated, Mr. Dietert displayed 30 samples of casting losses which were due to sand condition. He also exhibited a complete sand testing laboratory for sand control and a display on sand grading prepared by the American Foundrymen's association.

A Correction

Through error in reporting, the Henry Lindahl Foundry & Machine Co., in the tabulation "Representative Foundries in Chicago," in the April 15 issue of THE FOUNDRY, is credited with only six tons daily capacity. The correct figure is 15 tons per day. Fred H. Lindahl is president, Harold A. Lindahl, vice president and general manager, and Leonard Stroberg is foundry superintendent.

Herbert A. May has been appointed assistant to the president, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. May will have his headquarters in the Grant building, Pittsburgh. Malcolm Carrington, formerly director of finished stocks has been appointed assistant to the vice president.

BILL

By Pat Dwyer

Hears of Bread Cast Upon Water

THE other day," Bill said, "I had a letter from a fellow which kind of convinced me that perhaps after all there is something in the old saying that if you cast your bread upon the waters, it will return after many days." "Why should you wait until this late day," I inquired, "to come to such a conclusion? You must have seen hundreds of illustrations of the truth of that old saying." "Well, I'll tell you. I never dwelt on the figurative meaning of the thing. Taking the saying in a literal sense, it always sounded kind of silly. You throw a hunk of bread in the water, any kind of water and in five minutes it is converted into an object that no person would accept as a gift. In strict justice perhaps I should except a person in the last stages of starvation in the Arctic waste or in the midst of a burning desert. However, in either of these hypothetical instances the probability does not apply. In the Arctic waste the crust would be frozen so solidly the finder could not gnaw it without breaking his teeth. The burning desert has not sufficient water to float a crust of bread. Therefore the famished lad could not find it.

"Look at the subject in another light. Any reference to an object returning, is based on the assumption that the carrier is in motion. In this particular instance one is justified in the assumption that the bread is thrown on the surface of a stream or river. Rivers eventually find their way to the sea, and anything that keeps afloat to that point is washed out of sight. The tide flows back a certain distance in some rivers, but the chance of a crust of bread floating back is exceedingly remote. Unless the aforesaid crust is thrown overboard near the mouth of the river, it will not even reach the sea. If it does not sink during the first half hour, it will be gobbled up by a gull or a hungry fish.

"Any old time you feel like throwing bread on the waters, you may kiss it goodbye. You'll never see it again."

"The argument seems plausible enough," I admitted, "and I am inclined to agree with you. However, there is one point you apparently have overlooked, a minor point perhaps, but still a point that interferes to a slight extent with the otherwise perfect surface of our unanimity. It

Some Bread That Never Will Come Back

is the one thorn on the rose stem, the little splinter that remains in the tooth cavity, the speck of dust in the eye, the worm in the apple, the—the —In a word, my lad, and not to put too fine a point upon it, you are not consistent, which simply is another way of saying you are all wet."

"If you want to be so fussy," Bill pointed out, "any bread thrown upon the water is bound to become all wet. Try that one on your key bugle. After you are through blowing bubbles perhaps you will lay the bugle to one side and kindly inform me wherein I am not, or have not been consistent."

"That's what comes," I said, "from allowing your mind to wander away at loose ends like a line of clothes flapping in the breeze. You remind me of the story of the two drunks sitting side by side in a train.

"One pickled owl turned to his friend and inquired solemnly 'Wha' time ish?'

"The second lad extracted a matchbox from his vest pocket, turned it around a couple of times, tried to open it, abandoned the attempt, fixed a watery eye on his companions and announced gravely 'Thur'say!'

"'Wow?' says the first lad 'Lemme out, o'man. We musta pass' my station in dark!'"

"Tut, tut," Bill tutted reprovingly. "Now that our paternal government has succeeded in its heroic endeavor to banish the demon rum from the shores of this fair land, you should take shame to yourself in this ill timed levity. 'Tis said that the demon still lurks just outside the 12 mile limit, waiting—w-a-i-t-i-n-g! So beWARE—BEE-ah-wa-r-r-r-e! I bet I hit *B* below the staff that time. A perfect example of consistency, if you ask me, three Bs, all in a row." "Three *B*s in a row all right." I admitted, "but not a single one of them stands for consistency. Now, for a change, if you ask what they stand for, I might hazard the guess that they stand for bull, bunk and baloney, modern synonyms for the one time famous Bosh! In other words—if other words are needed—and I fear they are needed—you simply are ducking and dodging in an effort to escape from a tight corner." "Case of mistaken identity," Bill replied airily. "You must be thinking of two other fellas from Pittsburgh."

"No, I am not thinking of two other fellows from Pittsburgh or from Squeedunk or from Apahauki.

"In your original statement you admitted conversion to a belief in the saying that bread cast upon the waters will return after many days. Immediately thereafter you indulged in a long harangue to the effect that the feat was a physical impossibility. Now, without any more beating about the bush, where do you stand on this important question? Do you believe the bread will come back, or, do you hold to the belief that the man who coined the saying was only half baked?"

"That old gray memory of yours," Bill replied with mock solicitude, "ain't what she used to be. At the expense of great pains and accuracy I pointed out that the saying could not be taken literally, but that is a long way from saying that there may not be some truth in the saying if it is taken in a figurative sense.

"What prompted the remark was an instance where a man had extended some small courtesies to a stranger and many years afterward the stranger presented him with a handsome job. The details of the second

episode I had from the letter I mentioned. If you have the time and the inclination to listen, if you can restrain your impatience and your desire to monopolize the center of the stage for a few minutes, I shall commence at the beginning and unfold the tale for your particular benefit."

'Twas Near the End o' the Week Anyway

"Rather a neat idea, commencing at the beginning. I wonder how you happened to hit upon it?"

"Just came to me in a flash," Bill admitted modestly. "The only way to present a story to a person of limited mentality is to commence at the beginning and then string the incidents along in orderly sequence. If you have no further suggestions to offer for the good and welfare of the order, we shall proceed to the next item on the program: Correspondence from Sister Locals."

"Sounds to me like one of the meeting nights in old 324 in the vacant room above Morrison's carriage shop. Do you remember the night we put on the smoker and a worthy brother tossed a lighted cigar butt among the shavings on the lower floor? We had to do some tall hustling for the good of the order that night. I often have wondered what would have happened if the blaze had not been discovered.

"That was 30 years ago—let's see—yes, 30 years ago this coming fall and yet, do you know, down to this day whenever I smell paint or varnish or oak shavings, the picture of that night is the first to flash in my mind. I suppose you have noticed that the sense of smell is the most active agent yet discovered for reviving the memory—Oh! By the way, that reminds me. You were thinking of beginning a story at the beginning. Well, carry on dear lad. Don't let me stop you. Your use of a phrase from the ritual touched a bulb in the battery of my memory and caused it to glow for a moment. Everything now is dark again and I await with interest the *Story of the Crust of Bread*, or, *It's a Long Loaf That Has No Turn!*" *How's that, eh?*

"You certainly are one grand little waiter. I often marvel at the wonderful patience you display. Instead of butting in with a lot of silly and totally uncalled for remarks, you sit there with hands primly folded, with both ears cocked forward in respectful attention and with an adoring look in your little weasel eyes. You would not think of interrupting Not you! Not any oftener than every 15 seconds by any reliable stop watch. Say, listen. I'll give you one more chance. Another peep out of you, little sleepy head, and I'll call in old Raw-head and bloody-bones, who'll sink his fangs in the back of your old yellow neck and drag you off to his lair under the roots of the old pine tree. The hero of this plain and unvarnished tale, to wit, the bread caster, was a lad o'pairts, as they say in his native land, and was serving as master mechanic in the coke oven department of a steel plant where I worked at one time. He was a thrifty lad, a trait which I have been told is not uncommon to his nationality, although to tell you the truth I have met several members of the race whose fingers are about as well adapted to holding money as a half inch riddle is adapted to holding water. I suppose you are familiar with the fact that fingers of improvident people do not touch at any point along their length when the hands are at rest. Let's see your's. Ah! I thought so. Fingers like a duck's. All they lack is the web."

"I may have fingers like a duck's pedal extremeties," I said, "but there the resemblance—if any—ceases. Lay off the comparisons and continue with your Quack-quack."

"Spoken like a man and a brother," Bill agreed heartily. "Birds of a feather and all that kind of thing.

"Le's see, where was I? Something about this bird's thrifty habits. He told me one time that when he started to work, at some perfectly ghastly age like 9 or 10, he made up his mind to live on half his income, whatever it might be, and save the remainder.

"I don't know how he managed to survive during the first few years, but he stuck to his resolution manfully and packed away the shillings and six penny bits in the bank every payday. I may be wrong about the bank. Perhaps he packed the coin away in the old sock. The only flaw in this theory is that the only socks he had were on his feet. However, the fact remains that he collected enough to carry him across the Atlantic.

"He was a clever and ingenious lad and it goes without saying, that having served his time in the thorough going old country manner, he was a highly competent workman. He progressed from one job to another, each to some extent better than the one before and naturally his compensation increased with each change. Through all the changes he stuck to the old rule and salted away half the pay check every month.

"That was not the only thing he salted away. The only recreation in which he indulged, was fishing. He had all the angler's love for the sport and pride in his proficiency, but he also had the happy faculty of turning his pride and love to practical account.

"Shortly after he had settled in our midst he acquired a bicycle, not as a luxury or a vulgar indication of opulence, but purely as a dividend earning piece of equipment. It increased the range of his activities and allowed him to tap virgin fishing territory where the trout were big and plentiful and fought with each other for the pleasure of taking a hook.

Shipping Note: Trawler Arrives with Full Fare

"He came back from week end raids into this piscatorial paradise with a loaded basket strapped to the bicycle. The contents of the basket was, or were—Confound that word, I always trip over it—What I mean to say is he cleaned the fish and then

salted them all away for the winter.

"A friend of the G.M. going through the plant one day stopped for a few minutes chat with Angus. A chance remark on the color of the stream leaving the coal washer, brought up the subject of fishing and Angus was delighted to find that his visitor was a man of rare discrimination, fully competent to discuss the finer points of the art. He admitted that he was a stranger in that part of the country and professed the greatest astonishment, tinged with envious admiration, at the recital of some of Angus' exploits. The result of course was that on the following day, Angus accompanied him to his pet stream and what they did to the fish that day was just too bad.

"Several years passed and then through one of these shakeups that seem to afflict steel plants periodically, Angus found himself out of a job. He went out to the West coast and loafed around for a while waiting for something to turn up. He still had the bicycle and fishing rod and whiled away some of the time in fishing excursions.

"On one trip he fell in with his former acquaintance and they spent a delightful day together. When the lad learned that Angus was out of a job he professed the most lively interest.

" 'I'm on a vacation now,' he said, 'but I'll be back on the job in another week. You come down to the office of the A.B.&C. railroad on the 10th and ask for Jim Jones. I am hooked up with that outfit and I may be able to put in a word for you.'

"Angus was Johnny on the spot on the 10th. The man in the information booth eyed him queerly when he asked for Jim Jones, but told him civily enough how to reach Mr. Jones' office. Angus walked down the corridor and then his eyes popped when he saw the sign on the door: J. Jones, Vice Pres. & Gen. Mgr.

"That's all. Old J. shook him cordially by the hand and asked him if he would accept the position of superintendent of motive power. Angus is there yet.

"This idea of throwing bread upon the waters," Bill continued, "seems to work out pretty satisfactorily whether it is done intentionally, that is with the expectation of securing a return, or not. In the first instance, the return, when and if it does come, is doubly welcome because it is unexpected. However, occasions sometimes arise where a man profitably may throw a few slices on the water with the ultimate object of having them return some day, buttered on both sides, or maybe reposing under a heavy layer of jam.

"Some time ago I had an inquiry from a foreign foundryman who complained of the difficulty he had in securing sufficient orders to keep his plant running to capacity. He would welcome suggestions on the principal fields for steel castings, lists of potential customers, methods in use elsewhere for building up a clientele.

"The problem he outlined is one that confronts owners and managers of every foundry here or abroad, irrespective of whether they are engaged in the production of gray iron, malleable iron, steel or any of the different varieties of nonferrous castings. In fact, the problem is perennial and will continue to plague foundrymen until the consuming capacity of the country exceeds the productive capacity of the plants engaged in the foundry industry.

"Conditions more or less similar to those which prevailed during the late war, arise occasionally when all manufacturing plants are pushed to and beyond capacity. In normal times the opposite is the case with not enough business to go around. The owner of each plant must depend on his own effort and ingenuity to get a share. In fact the extent to which the order book is filled, is a fair criterion of his ability to compete with his business rivals.

"With a few notable exceptions, foundrymen are at the tail of the industrial procession in soliciting business. The idea of investing any money in an experimental line rarely is considered and even more rarely carried into execution. The majority of foundrymen—at least tacitly—say in effect: 'Well, here I am ready to make castings, ready to execute any order left by a customer. Customers who need castings know that I am here. When they need any castings they will notify me.'

"That line of reasoning was quite logical when establishments were few and small and when each shop only served a limited community. Times and conditions have changed to keep pace with the increase in population and the increase in the needs of these same people. In these modern days, the only way to get business either in the foundry or in any other line, is to go out and get it. Before starting out, the prudent foundryman will fortify himself with arguments that will appeal to a customer who is free to choose between many purveyors of castings. It may be price, weight, terms, delivery date or quality, but his total number of appeal points must be greater than those presented by any of his rivals.

"Railroad, mining and the pulp and paper industries offer the principal fields for steel castings in the country where the inquiry originated. Two large steel casting plants have been able up to the present to take care of nearly all requirements. In addition to these five smaller plants make a considerable number of steel castings, and several gray iron foundries are equipped either with converters or electric furnaces in which occasional heats of steel are made. From the foregoing it is apparent that he has a real man's job on his hands in an attempt to divert orders to his plant.

"He can secure lists of steel castings users from many sources; stock lists, public utilities, telephone and city directories, technical magazines and from the advertising sections of newspapers published in the communities where industrial plants are located.

"A little bread cast upon the water frequently takes the form of an advertisement in the technical magazines that are read by the men who buy and use steel castings."

A. S. A. To Standardize Plumbing Equipment

American Standards association, 29 West Thirty-ninth street, New York, recently has undertaken a project which involves the standardization of plumbing equipment. A sectional committee was appointed in 1927 at the request of the American Society of Mechanical Engineers. The work has been divided among eight subcommittees on staple vitreous china; staple porcelain plumbing fixtures; plumbers threads; traps; brass plumbing products; copper water tube fittings; cast iron soil pipe and fittings; and a subcommittee to deal with the report entitled "Recommended Minimum Requirements for Plumbing," developed by the subcommittee on plumbing of the building code committee appointed under the auspices of the United States department of commerce. The sectional committee is under the chairmanship of William C. Groeniger, consulting sanitary engineer, Columbus, O.

Comments on X-ray Use

Westinghouse X-ray Co., East Pittsburgh, Pa., subsidiary of the Westinghouse Electric & Mfg. Co., has broadcast a comment by Harold G. Petsing, educational director, on the industrial use of x-rays. Mr. Petsing tells how x-rays are being applied industrially and points to an example of their use in the inspection of castings for the main support of the tripod arrangement carrying the revolving autogyro on an autogyro plane. X-ray inspected castings for that purpose have functioned perfectly, according to a statement made by Mr. Petsing.

GANGWAY!

The Skipper's *Daughter* Takes the Wheel

DETROIT has quite a reputation as a foundry town, take it any way you like up or down, crossways or sashay down the middle and yet so far as we are aware—and in all modesty we admit that our big ears are fairly sensitive to what is going on—we repeat, so far as we are aware up to the present no mention has been made of a feature in the Detroit foundry industry which sets it apart, practically in a class by itself.

What, you naturally inquire, is the distinctive feature in the Detroit foundry industry that sets it apart from the industry in all the other towns and villages in this fair land of the free and the home of the brave. Free in the sense that for lo these many moons, vast multitudes have not been subjected to the indignity of punching a time clock and brave in the sense that they have continued to exist without visible means of support.

Know ye then by these presents that the *haid* man in one of Detroit's foundries, the center around which all the activities revolve, the holder of the privy seal and the purse strings, the man who says to this man GO and he goeth and to that man COME and he cometh, in a word and to be brief the BOSS, is a lady, Miss Elsie Nelson, manager the Nelson Foundry Co., West Lafayette Boulevard.

In witness whereof behold the accompanying photographic reproduction of a girl in her sunny twenties with the deep wide set eyes of dauntless Viking ancestors, offset by the slightly humorous quirk at the corners of the mouth, an inheritance from an Irish mother. Other characteristics whether inherited or acquired—who cares so long as one has 'em?—induced her to take over the management of the business 3 years ago on the death of her father.

No particularly special or spectacular endowment is required to go through the formality of taking over the management of a business. The test comes in the actual taking up of the load, the responsibilities, after the momentum incident to the preceding driving force has ceased. Successfully operating a foundry for the past 3 years under present day fiercely competitive conditions, would seem to indicate that Miss Nelson knows her way around, that she knows a pot of metal is not necessarily a metal pot, that brass washers are not washing machines, that cores are not apple remnants, that a chaplet is not an ornament for the hair, that a runner is not a person with a pair of nimble legs and that core wash is not a variety of soap.

As daddy's chubby little pet she played in the foundry and built sand castles and mud pies when her contemporaries were sitting primly in starched muslin on the front porch playing with their dolls. She is discreetly silent on the evening sessions when her mother had to scrub the grimy little paws and separate the sand from the long curly locks, but she has a vivid recollection of her father's quiet amusement over the process and his paternal pride in a daughter who found a fascination in a business to which he had devoted a life time.

Busy and colorful high school years with their never ending scholastic and social activities interfered to some extent with intimate participation in foundry practice, but did not damp her interest. She still found a thrill in contemplating the speed and manual skill displayed by the molders, in the symmetry and accuracy of the mold cavities, in the flaming furnaces where drab and chunky ingots and miscellaneous scrap were transformed by subtle alchemy into pools of molten gold.

Spectacle of brawny men snatching the glowing pots from the flame and smoke of the open furnaces and bearing them away to the line of waiting molds, subconsciously stirred primeval emotions dating back to the period of Longfellow's *Skeleton in Armor*. The lad who stole the chief's daughter and then sunk the father's ship when that mistaken worthy pursued him under the foolish impression that he could recover the girl.

As with his wings aslant
Sails the fierce cormorant
Seeking some rocky haunt
With his prey laden.
So, toward the open main
Beating to sea again
Through the wild hurricane
Bore I the maiden!

The general idea may be boiled down to the familiar slogan of a great maritime nation "What We Have, We Hold!" The Nelson foundry was established by the father, but when he had to relinquish the wheel, a perfectly competent daughter was there to step into his sou'wester and great sea boots. Skoal!

New England Founders Discuss Costs

Seventy one members of the New England Foundrymen's association attended the regular April meeting of the society held at the Svea Gille club, Shrewsbury, Mass., April 8. John L. Carter, chairman of the cost committee, Gray Iron institute, Cleveland, and Charles A. Klaus, cost accountant for the same society, spoke on "Cost Control in a Jobbing Foundry."

The annual spring meeting of the American Refractories institute will be held in the Greenbrier, White Sulphur Springs, W. Va., May 25 and 26.

What Others Are Thinking

Abstracts Selected from European Foundry Literature

Obtaining Hot Metal

A Few Practical Notes on the Operation of Cupolas and the Means of Obtaining Hot Metal, (Quelques Donnees Pratiques sur la Conduite des Cubilots et les Moyens d'Obtenir de la Fonte Chaude), by E. Croonen, *Bulletin of the Association Technique de Fonderie de Belgique,* Liege, February, 1931.

The article is the result of studies made on a battery of seven cupolas operated by Compagnie Generals des Conduites d'Eau de Liege. The maximum capacity of the seven cupolas is 300 metric tons (338.6 net tons) per day. Each operation of one cupola lasts from 8 to 17 hours and varies from 30 to 135 tons (33 to 149 net tons). The composition of the iron is constant during the whole melting operation. Analysis of the foundry iron is as follows: Silcon 2.00 to 2.25 per cent; manganese 0.5 per cent; phosphorus 1.00 to 1.4 per cent; total carbon 3.4 per cent. The iron used for centrifugal castings contains more silicon, but less phosphorus. The foundry specializes in the manufacture of cast-iron pipe, which is subjected to hydraulic tests.

The results of these tests show that a large portion of the defective pipe could be traced to the *life* of the iron, that is, its aptitude to remain fluid as long as possible after it has left the cupola. Preliminary remarks are made on its oxidation in relation to the speed of combustion, and on the nature of the irons used. The remainder of the discussion centers around the characteristics of the cupolas used, the relation between the quantity of coke used and of pressure, the relation between the quantity of melted iron and coke, the melting temperature in relation to various factors of operation, and the influence of the speed of combustion.

It is stated that the optimum percentage of coke ranges from 10.25 to 10.75. For a consumption of 700 kilograms (1540 pounds) of coke per hour and per square meter (10.76 square feet) the increase of temperature for each 1 per cent of coke is about 15 degrees when the coke percentage varies from 9 to 10 per cent. It is recalled that when melted iron is transported from the cupola to another part of the foundry, a drop in temperature of as much as 150 degree Cent. (300 degrees Fahr.) occurs if the molds are situated at a long distance from the cupola. A ladle containing from one to two tons loses about 6 degrees per minute in transportation.

Consequently, three minutes are sufficient to do away with the increased temperature brought about by an addition of coke. On the other hand, it is not recommended to go below 9 per cent coke percentage, because when low figures are reached the castings do not pass the hydraulic test. For normal operation it is recommended to use 750 kilograms (1650 pounds) of coke per hour and per square meter (10.76 square feet) for a cupola 1.15 meters (45.3 inches) in diameter and 5 meters (16.4 feet) in height, and with a pressure of 650 millimeters. (25.6 inches). A discussion on the thermal balance of the cupolas also is included.

Gases Existing in Metals

Gases in Metals, By C. J. Smithells, *Metal Industry,* London, March 6, 1931.

Gases always are present in industrial metals but little is known about their quantity, distribution and effect. Experimental evidence refers only to the common gases and to a limited number of metals and alloys. Laws governing the solubility of gases in ordinary liquids do not hold in the case of molten metals. In ordinary liquids the solubility decreases as the temperature rises while in liquid metals the solubility increases with higher temperatures. The solubility of gases generally is less in the solid state than in the liquid and falls further as the metal cools to room temperature.

Most metals combine with oxygen to form oxides, although some of the noble metals appear to absorb it. Hydrogen absorption by a number of metals has been studied and in most cases it was found the solubility increased as practically a linear function up to the melting point. As the solubility of a gas usually is greater in the liquid than in the solid state, the amount of gas dissolved depends on the time of heating and the concentration of the gas in the surrounding atmosphere. The amount of hydrogen absorbed by a metal is proportional to the square root of the pressure. That has been found to be the case with tantalum, nickel, iron and copper and indicates that the gas probably is dissolved in the atomic state. The slow rate at which the absorption takes place is due in a small degree to the dissociation of the gas at the metal surface.

Metals may be divided into three classes with respect to their affinity for hydrogen. Nickel, lead, iron, cobalt and copper form alloy systems. Alkaline earth and alkali metals form hydrides. Gold, silver, beryllium and magnesium show practically no absorption. Nitrogen combines with a number of metals to form nitrides but is absorbed as a gas by comparatively few.

Total volume of gas that can be extracted from brass, copper, aluminum, or duralumin is comparatively small and is of the same order as the volume of the metal. Nickel sometimes contains 100 times its own volume of gas. Electrolytic copper contains a much larger quantity of gas than fire-refined copper and the proportion of hydrogen is high. Electrolytic nickel contains about its own volume of gas and that is mainly hydrogen. Carbon dioxide forms the major constituent in gases from other samples.

Aluminum alloy castings sometimes show pin holes throughout the casting. That defect appears to develop more readily in sand-cast alloys than in chill or castings or after slow solidification in the crucible. The holes are due to the evolution of dissolved gases on freezing. Two methods have been suggested for eliminating that defect. One is to allow the melt to solidify in the crucible and then reheat rapidly to the pouring temperature. The other consists of passing an inert gas such as nitrogen or chlorine through the metal until it solidifies and then reheating it and casting.

Machinability Discussed

The Machinability of Cast Irons in the Process of Turning, (Die Zerspanbarkeit des Gusseisens in Drehvorgang), by A. Wallichs and H. Dabringhaus, *Die Giesserei,* Dusseldorf, Germany, Dec 5 and 12, 1930.

Investigators in Germany have shown much interest in the machinability of materials. That property of rolled and cast steel has been investigated. Chipability or machinability of cast iron now has been studied and may be compared with other materials. Specimen were rough-turned at definite cutting speeds, and the depth of cut and feed were controlled. The cutting operation was continued until the tool become blunt. From the time-speed curves obtained for each depth of cut and feed, the cutting speed was determined at which the tool becomes blunt after 60 minutes. The cutting speed was taken as a criterion of machinability. A high-speed steel quenched at 2372 degrees Fahr. but not tempered, with a cross-section of 1.18 x 1.18 inches at the shank, a clearance angle of 8 degrees, and a cutting angle of 14 degrees was used.

Machinability of cast iron without the casting skin is the same whether the iron is cast in sand or loam. Doubling the feed decreases the cutting speed twice as much as doubling the depth of cut. The experiments were carried out on 17 pipes, 59.1 inches in length, 19.7 inches outside diameter, 1.97 inches wall thickness and various chemical compositions. Curves were ploted showing working time and cutting speed. Results showed that the higher the cutting speed the greater the declination of the curves. Turnings were found to be longer with a small feed and hard iron.

A relationship exists between cutting speed and tensile strength and hardness but it is not linear. Microscopic examination showed that structure exerts no influence on machinability provided the structure does not affect hardness. A chart is shown by which the cutting speed can be ascertained if the depth of cut and feed are known.

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The Shakeout

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¶ In Defense of Claim Jumpers

DURING the early pioneer days when prospectors were scattered through the western hills, a *claim jumper* was an unpopular individual. His mode of operation was to discover mining properties staked out by others and endeavor either to beat them to registration, falsify records or await some lapse in operating rules that would permit him to acquire property rightfully belonging to others. All the despicable traits of human nature were ascribed to a claim jumper. He was compared to a coyote, a skunk or other low, odoriferous animal and no one loved him.

PERHAPS the claim jumper was not such a bad citizen after all, since his malicious activity injured only individuals. What of the manufacturer who, when circumscribed by freight and delivery restrictions to a certain area, jumps outside that area to sell *below cost* in competition with others? Such practice indulged in by a few suffering from the disease known as tonnage delusion is operating to depress prices below all justifiable levels. This dumping below cost outside a foundryman's logical area of sales is met by similar activity from competitors who come into his territory. The consequent low price, usually below all justifiable levels of cost, demoralizes the entire market.

TRADE associations, unfortunately, find no ready weapon to combat this piracy. Trade practice agreements, which in the past were thought to militate against selling below known cost in interstate commerce proved to be a flimsy prop. The trade association executive who can find some structure upon which to build resistance to dumping, either through leverage of popular opinion as represented in his own group or by more drastic means can establish fame and write his own ticket in reward.

¶ More Machines; More Castings

THE extent to which machinery is furthering industrial expansion throughout the world, thus raising the standard of living by making articles available which previously could not be obtained, is revealed in an interesting manner in a survey by W. H. Rastall, chief, industrial machinery division, department of commerce.

VALUE of machinery consumed annually throughout the world has reached the enormous total of $5,500,000,000. The United States accounts for $2,500,000,000 of this total, which, on a per capita basis means that every man, woman and child in this country each year installs machinery valued at $23. The yearly per capita consumption of machinery in Great Britain is valued at $10, in Germany $9, India only 17 cents and China 5 cents. One-half million workers throughout the United States produce 57 per cent of the world's annual output.

SINCE castings constitute one of the most important engineering materials utilized in the construction of practically all types of machine, the foundry industry has contributed much to progress in the manufacture of machinery.

¶ Competing for the Best

WITHIN the next few weeks, thousands of young men will leave the various engineering and technical schools through the country, to take their places in industry. After periods of training varying widely in duration, the most successful will find opportunities open for continued advancement. The industrial leaders of tomorrow in many instances will develop from the technical graduates of today.

INDUSTRY in general has been anticipating the coming graduations. For some time, representatives of various industries have been visiting the technical schools and colleges, interviewing those graduates having the proper qualifications and seeking a job, with the result that many members of the graduating classes have been offered positions. In this way, each industry endeavors and usually is successful in selecting the young men best fitted for the particular line of work which is to be followed.

WHILE some of the present graduating class undoubtedly will become a part of the personnel of the foundry industry, based on past statistics, the number will be small in comparison with the size and importance of the industry. The rapid mechanization of the foundry industry in recent years has led to a greater realization of the necessity for technically trained men in the castings field, but the actual demand has not kept pace with potential requirements.

IMPORTANT leaders of the industry see the time not far distant when the management of foundries will realize fully the need for technically trained men, and will endeavor to compete for the best prospects in the same manner as public utilities, large electrical companies, chemical concerns, etc., are doing today.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

WESLEY LAMBERT, past president of the Institute of British Foundrymen and a member of the council of the Institute of Metals, has resigned as manager, metallurgical department, Messrs. J. Stone & Co. Ltd., Deptford and Charlton, England with which he has been connected 20 years. He has been retained by that company in an advisory capacity. Mr. Lambert was educated at Roan school, Greenwich and at King's college, London. In 1890, he was appointed assistant metallurgist, Royal Gun Factories, Woolwich, and in 1894 was appointed metallurgist and lecturer, Ottoman Naval arsenal. He returned to the Royal Gun Factories in 1901 as chief metallurgist and later received a treasury award for special services. At one time he was special lecturer at the Sir John Cass Technical institute, London university. Mr. Lambert has received decorations from several countries for his technical work, among them being the Order of Medjidieh from Turkey. Recently he was signally honored by receiving the decoration of Commander, Order of the British Empire. Mr. Lambert is well known to foundrymen throughout the world and will be remembered by the American delegation to the third International Foundrymen's congress for his cordial hospitality to the overseas visitors. In addition to his affiliation with the I. B. F. and the Institute of Metals, he is a member of the Institute of Civil Engineers, Institute of Naval Architects, Institute of Marine Engineers, American Society for Testing Materials and others. He also served as a member of committees and panels of the British Engineering Standards association and is a fellow of the Chemical society. Mr. Lambert's future plans are unannounced.

John Duffy, superintendent, Chemung Foundry Corp., Elmira, N. Y., will sail May 15 from New York on the OLYMPIC for a short visit to England.

J. L. Blair, formerly associated with the W. A. Riddell Co., Bucyrus, O., as foundry and sales manager, has become affiliated with the Swedish Crucible Steel Co., Detroit.

Harry W. Petty, formerly Cleveland district sales manager, American Steel Foundries, Chicago, has joined the sales department of Union Steel Casting Co., Pittsburgh.

M. G. Sternberg has been appointed operating manager of the Continental Roll & Steel Foundry Co., East Chicago, Ind. For the past five years Mr. Sternberg has been general superintendent of the Hubbard Steel Foundry Co., East Chicago, Ind., which was merged with the Duquesne Steel Foundry Co., Coraopolis, Pa., and Wheeling Mold & Foundry Co., Wheeling, W. Va. in August, 1930, to form the Continental Roll & Steel Foundry Co.

Mark F. Hoeper, Milwaukee, has been appointed general manager, Jenkins Machine Co., Sheboygan Falls, Wis. He was identified from 1911 to

Wesley Lambert

1913 with the former Falls Machine Co., Sheboygan Falls, and then became affiliated with Jenkins Machine Co., Sheboygan, but retired shortly after the consolidation of Falls Machine Co., Jenkins Machine Co., and E. B. Hayes Machine Co., Oshkosh, Wis., into Jenkins Machine Co., Sheboygan Falls.

Ernst C. Heyde, formerly foundry superintendent, Skalla & Co., Buenos Aires, Argentina, South America, has returned to the United States and now is in charge of the pattern shop and foundry equipment for the California Foundry Co., Los Angeles. Mr. Heyde began his foundry career as an apprentice with the Wolff Mfg. Co., Chicago, in 1903. He remained there after serving his apprenticeship and in 1918 was appointed foreman of the pattern shops and in 1921 was promoted to assistant superintendent. He left that company in 1922, and went to the Pacific Coast where he took charge of pattern and equipment for the Pacific Sanitary Mfg. Co., San Francisco, later known as the Standard Sanitary Co., a position he held until he went to South America in 1929.

Ohio Founders Meet at Toledo

The Toledo group of the Ohio Foundries Inc., in co-operation with the Toledo Foundries association held a meeting at the Toledo chamber of commerce, corner St. Clair and Jefferson streets, Toledo, April 30. Nonferrous metallurgy and sand occupied the attention of those present. Ralph L. Binney, Binney Castings Co., Toledo, addressed the meeting on "Developments in Nonferrous Metallurgy," while Harry W. Deitert, United States Radiator Co., Detroit, spoke on "Foundry Sand Losses."

The committee in charge of arrangements for the meeting was composed of Charles Carson, National Supply Co., L. P. Henry, Maumee Malleable Castings Co., and George Thompson, Thompson-Owens Corp., all of Toledo.

Will Hold May Meeting

The annual meeting of the British Iron and Steel institute will be held at the Institution of Civil Engineers, Westminster, London, on Thursday and Friday, May 7 and 8. At the morning session on May 7, the newly-elected president, Col. Sir Charles Wright, Baldwins, Ltd., will be inducted into the chair, and the Bessemer gold medal will be presented to Sir Harold Carpenter, Imperial College of Science and Technology, London.

At the morning session of the second day, the Carnegie gold medal will be awarded to Dr. E. Valenta, Skoda Works, Pilsen, while the Williams prize will be awarded to Frank Bainbridge, who is already a Carnegie medallist. Afternoon sessions on both days will be devoted to the presentation of papers relating to corrosion, structure of ferrite, refractories, blast furnace data, etc.

R. E. J. Summers has resigned his position as vice president and contract manger, H. K. Ferguson Co., Cleveland, to become president, Summers Engineers & Constructors Inc., with offices in the Terminal Tower building, Cleveland, and the Graybar building, New York. Charles H. Fowler will be in charge of the Cleveland office of the new company.

OBITUARY

W. H. Cavnah, secretary-treasurer of Canton Foundry & Machine Co., Canton, O., died recently.

George C. Stone, 67, treasurer and manager, Clinton Foundry Co., Clinton, Mass., died April 10.

Philip O. Schleussner, aged 53, first vice president, Roessler & Hasslacher Chemical Co. Inc., New York, died recently in Stamford, Conn.

George H. Carson, 65, president of Harrison Square Foundry Co., Boston, died in Dorchester, Mass., April 1.

Beverly Lyon Worden, 61 years old, president, Cutler-Hammer Mfg. Co., New York and Milwaukee, died March 28 at his home in West Orange, N. J.

Stanley A. Mallette, treasurer, American Car & Foundry Co., New York, died March 30 at his home in Scarsdale, N. Y. He was 61 years old.

George A. Lance, 81 years old, president, Lance Machine Shop & Foundry Co., Watertown, N. Y., died March 31 in Watertown.

James Spence, 60 years old, head of the James Spence Iron Foundry, Jersey City, N. J., died recently. He had engaged in the foundry business for 20 years.

George R. Metcalf Sr., chairman of the board, Erie Malleable Iron Co., Erie, Pa., since 1928 and prior to that president of the company, died recently at his home in Erie.

George L. Pettibone, 55 years old, connected with Rock Island Plow Co., Rock Island, Ill., died recently. He had been associated with Emerson-Brantingham Mfg. Co. for 22 years as branch manager at Harrisburg, Pa., and at Dallas, Tex.

John Boswell, 55 years old, superintendent, American Car & Foundry Co., Granite City, Ill., died recently at his home there. He had been employed by the American company for the past 20 years and recently had charge of the erecting department.

Emil Jacobson, 78 years old, secretary, Edna Brass Mfg. Co., Cincinnati, died recently. He was born in Manchester, England, came to this country and settled in Cincinnati when he was 20 years old. He had been associated with the Edna company for 30 years.

Stanton R. Costley, for many years identified with the foundry equipment industry, died recently in Florida. Mr. Costley made his home in Pittsburgh and for 30 years was affiliated with the sales department of the J. S. McCormick Co., Pittsburgh. He retired from active business several years ago.

John Howard Yardsley, a founder of the Philadelphia Car Wheel Co Philadelphia, died at his home in that city recently. He was a vice president of the company when it was

DIRECTORY OF FOUNDRY ASSOCIATIONS

American Foundrymen's Association

President, N. K. B. Patch, Lumen Bearing Co., Buffalo; executive secretary-treasurer, C. E. Hoyt, 222 West Adams street, Chicago; technical secretary, R. E. Kennedy, 222 West Adams street, Chicago. Annual meeting, Stevens hotel, Chicago, May 4-7, 1931.

Associated Brass Founders of New England

President, George W. Thornburg, Crescent Park Brass Foundry, Waltham, Mass.; secretary, Herbert H. Klein, Pennsylvania Foundry Supply Co., 310 Congress street, Boston. Meetings the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. McArthur, Washington Iron Works; secretary, W. J. Wark, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. Hire, Hire Foundry Co., Peoria, Ill.; secretary, Franklin Whitehead, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, L. E. Gilmore, Crane Co., Chicago; secretary, Albert N. Wallin, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, Carl S. Neumann, Union Mfg. Co., New Britain, Conn.; secretary, Charles S. Parker, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

Connecticut Nonferrous Foundrymen's Association

President, C. H. Blanchard, Reading Steel Casting Co., Pratt & Cady division, Hartford, Conn.; secretary, C. D. Elliott, Wilcox, Crittenden Co. Inc., Middletown, Conn. Meetings held the second Monday of each month at place to be named. Recent meetings have been held at Hotel Garde, New Haven, Conn.

Detroit Foundrymen's Association

President, James L. Mahon, American Car & Foundry Co.; secretary, William J. Muhlitner, Great Lakes Foundry Sand Co., 2100 Penobscot building, Detroit. Meetings third Thursday in each month, except December, June, July and August at Ft. Shelby Hotel.

East Bay Foundrymen's Association

Secretary, O. R. Moller, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Electric Steel Founders' Research Group

Director, R. A. Bull, Central Office, 541 Diversey Parkway, Chicago.

Gray Iron Institute

President, B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J.; manager, Arthur J. Tuscany, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, R. R. Fauntleroy, Moline Malleable Iron Co., St. Charles, Ill.; secretary, Robert E. Belt, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, William Ember, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, William E. Paulson, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue, New York.

Newark Foundrymen's Association

President, W. H. Mantz Atlas Foundry Co., Irvington, N. J.; secretary, G. W. Hannay, Barnett Foundry & Machine Co., Irvington, N. J. Meeting called by president. Scheduled meeting date, May 27.

New England Foundrymen's Association

President, Luther J. Anthony, Glenwood Range Co., Taunton, Mass.; secretary, Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass. Meetings held the second Wednesday of each month excepting July and August at the Engineers club, 2 Commonwealth avenue, Boston. Outings usually are held in the months mentioned.

Ohio Foundries Association Inc.

President, A. H. Kramer, Advance Foundry Co., Dayton, O.; secretary, Robert Hoierman, 418 Penton building, Cleveland.

Pacific Coast Founders Association

President, Charles J. P. Hoehn, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. Truitt, 55 New Montgomery street, San Francisco.

Philadelphia Foundrymen's Association

President, C. F. Hopkins, Ajax Metal Co., Philadelphia; secretary, Earl Sparks, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association

President, W. E. Troutman, Duquesne Steel Foundry Co., Pittsburgh; secretary-treasurer, William J. Brant, Wm. J. Brant, Bessemer building, Pittsburgh. Meetings on the third Monday of the month, except in July and August at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, R. L. Eichman, Bettendorf Co., Bettendorf, Ia.; secretary-treasurer, Stanley Brah. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club

President, Horace R. Culling, Carondelet Foundry Co., St. Louis; secretary-treasurer, Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis. Meetings the fourth Thursday of the month at 6:30 p. m., at the American Annex hotel, Sixth and Market streets, St. Louis.

Southern Metal Trades Association

President, John S. Schofield, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. Dunn Jr., Flatiron building, Atlanta, Ga.

Steel Castings Development Bureau

Research Director, George Batty, 500 Stock Exchange building, Philadelphia.

Steel Founders' Society of America

President, W. H. Worrilow, Lebanon Steel Foundry, Lebanon, Pa.; managing director, G. P. Rogers, Graybar building, New York.

Tri-City Technical Council

Chairman, C. F. Scherer, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. Xander, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, William Hoppenjanz, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. Erhart, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, William J. Snyker, St. Paul Foundry Co., St. Paul; secretary-treasurer, C. E. Langdon, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, J. P. Jensen, Prescott Co., 1 West Lander street, Seattle; secretary, Edward C. Gustin, 3716 Grayson street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Western Foundrymen's Association

President, H. T. Hornsby, Joplin, Mo.; secretary, E. L. Graham, Acme Foundry & Machine Co., Coffeyville, Kans.

Wisconsin Gray Iron Foundry Group

Secretary, W. F. Bornfleth, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on second Wednesday of each month at Hotel Schroeder, Milwaukee.

merged with the National Car Wheel Co. When the later company was merged with the Southern Car Wheel Co. in 1924 he continued on as an executive, retiring in 1927.

Joseph S. Lovering Wharton, 80 years old, associated with the foundry industry in Philadelphia for more than half a century, died at his home at Cheltenham, near Philadelphia, March 17. He was born in Philadelphia and matriculated at the University of Pennsylvania, but left college to enter the J. S. L. Wharton foundry, established by his father. Subsequently this became the Harrison Safety Boiler Works and then the Cochrane Corp., of which he was president at the time of his death.

Edwin S. Slatery, retired president and general superintendent of the Muncie Foundry & Machine Co., Muncie, Ind., for the past 20 years, died Friday April 3 in Ball Memorial hospital. He had been in indifferent health for the past two years. Mr. Slatery was born in Pulaski county, Ind., Feb. 11, 1872 and after growing up was connected for varying periods with foundries in Indianapolis, Peoria, Ill., Detroit and Flint, Mich. He is survived by two daughters, Mrs. Renata H. Reamer and Mrs. Lillian Stevenson, Muncie; three sons Edwin J. and Walter B., of Muncie and Theodore R., New Philadelphia, Pa., and one brother George P., Slatery, Chicago.

Stanley Hale Bullard, vice president, the Bullard Co., Bridgeport, Conn., died March 22 at his home in Fairfield, Conn. He was 53 years old. Mr. Bullard was the son of Edward Payson Bullard, founder of the Bullard company, and was born July 4, 1877, in Hoboken, N. J. He had been prominent in the machine tool industry for the past 35 years. Following graduation from the New York Military academy in 1890, Mr. Bullard became a machinist apprentice in his father's plant. After completing his training, he joined the company and became the manager of the New York office, manager of the Eastern sales district and finally general sales manager. He was elected vice president and general works manager in 1915. He was interested both in civic and organization work.

William Allen Harris, senior director, Springfield Fire & Marine Insurance Co., Springfield, Mass., died April 5, at the age of 73. He was born in Springfield, Sept. 15, 1857 and spent his early youth in Rutland, Vt., where his father was a manufacturer of car wheels and heavy castings. Following his education at Troy Business school, Troy, N. Y., Highland Military academy, Worcester, Mass., and Phillips Andover, from which he was graduated in 1879 he became a partner in his father's business at Rutland. He remained there for a short time and in 1881 he went to Springfield and bought the Agawam Foundry owned by Wright & Emerson which he reorganized as the Springfield Foundry Co. He was secretary and manager of that company for approximately 10 years when he left to become sales agent for the Pratt & Cady Co., Hartford, Conn., now a subsidiary of the Reading Steel Casting Co., Reading, Pa. A short time later that company acquired an interest in the C. H. Bausch Iron Works, Holyoke, Mass., and the latter company was reorganized as the Bausch & Harris Machine Tool Co., with Mr. Harris as president. He continued affiliation with that company until 1903.

Ohio Group Announces Sectional Meeting

The spring sectional conference of the Ohio Foundries association will be in Cleveland, May 22, at the Cleveland Athletic club. The conference will open at 10 a. m. with a luncheon scheduled for 12 o'clock.

R. C. Good, metallurgical engineer, Electro Metallurgical Sales Corp., New York, will speak at the afternoon session on "Alloys and Their Effects in Iron and Steel with Particular Regard for Those Used as Scavenging Agents." E. L. Shaner editor, *Steel*, Cleveland, will address the meeting on 'What Would Influence a Better Price Level."

The program of the spring conference has been arranged by the program committee of which B. R. Pearse, Atlas Foundry Co., is chairman. He has been assisted by A. C. Denison, Fulton Foundry & Machine Co., and F. S. Wellman, Wellman Bronze Co., all of Cleveland.

Detroit Foundry Group Elects Officers

The feature of the April 16 meeting of the Detroit Foundrymen's association was the election of officers as follows: James L. Mahon, American Car & Foundry Co., Detroit, president; Peter W. Mulder, Almont Mfg. Co., Almont, Mich., vice president; Neil McArthur, Great Lakes Foundry Sand Co., Detroit, secretary; and Fred A. Cowen, Hickman, Williams & Co., Detroit, treasurer. The following were elected directors: Clarence H. Miller, Monarch Pattern Works, Detroit; Leslie G. Korte, Riley Stoker Corp., Detroit; Robert B. Crawford, Atlas Foundry Co., Detroit; Vaughn Reid, City Pattern Works, Detroit; Harry Rayner, Dodge Bros. Inc., Detroit; and Fred J. Walls, Wilson Foundry & Machine Co., Pontiac, Mich.

The nominating committee was composed of Robert Hope, chairman; Hutton H. Haley, American Foundry Equipment Co., Detroit; and Russell M. Scott, Packard Motor Car Co., Detroit. New officers will be installed at the May 21 meeting scheduled for the Fort Shelby hotel, Detroit.

Gas Regulator Provides Constant Pressure

Bastian-Blessing Co., Chicago, has developed a duplex, two-stage regulator, shown in the accompanying illustration, which delivers unvarying pressure to the welding or cutting torch. To overcome the difficulty of keeping the flame control constant, a special regulator for the first stage was designed and constructed to perform in balance with a precision regulator at the second stage. Both stages are thus governed by regulators having large size diaphragms, functioning at any desired pressure. The result of proper proportioning and balancing of the action of these two regulators is the maintenance of a constant neutral flame, regardless of fluctuations in tank pressure.

Regulator Provides Uniform Flame Regardless of Tank Pressure

The regulator is designed so that it not only can be used for welding and cutting but both operations can be performed simultaneously. A separate high pressure outlet with a needle valve is provided on the first-stage line. When the operator does not need his cutting torch, he simply closes this valve. An automatic safety outlet releases any abnormal or excess pressure caused by accident to any port of the equipment. The design also includes nonigniting seat and nozzle construction. The regulators are designed in models for use with oxygen, acetylene and hydrogen tanks.

Le Sauvage & Beardsley, Genesee building, Buffalo, has been appointed representative for monorail electric hoists in the Buffalo and Rochester districts by the American Engineering Co., Philadelphia. Weed & Co. also will continue to distribute the hoists in Buffalo and Rochester, cooperating with Le Sauvage & Beardsley.

Introduces Magnetic Molding Machine

Pneulec Ltd., Smethwick, near Birmingham, England, has developed a power squeeze, stripping molding machine that is operated magnetically and is controlled by only one switch. It is claimed that the magnetically operated type machine has a low operating and upkeep cost and that it is easy to install. The machine, shown in the accompanying illustration, is of the

Automatic Operation Is a Feature of the Machine

positive action type and operates with no jerk on either squeeze or draw. Operations are controlled by a push button.

The machine is designed to accommodate flasks as large as 27 x 18 inches. Provision is made for the adjustment of the stripping stools according to the size of the flask used. Either round, square or rectangular flasks may be utilized on the macihne. Length of stroke is 4 inches.

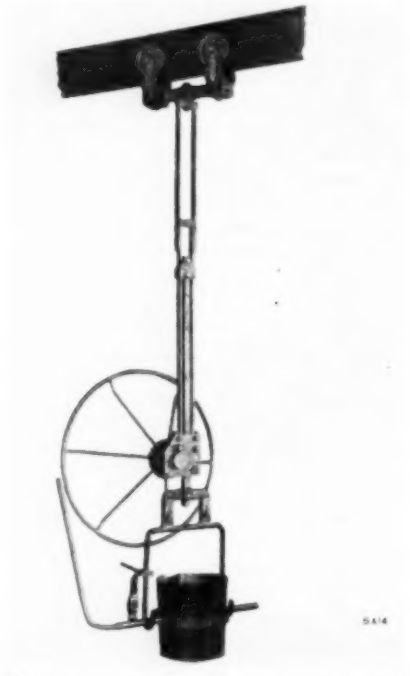
When the button is pressed, the machine goes through the cycle of operations without further control. Pattern table and flask are raised for the squeezing operation. The stripping stools are carried upward at the same time. At the end of the stroke, the stools are gripped in a dog type clutch and remain in that position, as shown in the accompanying illustration, carrying the flask while the pattern table returns to the normal position. The pressure head then is swung to the side, the mold is removed, the clutches are removed and the stools are returned to the normal position. Those operations are done automatically.

Current consumption is 100 amperes at 240 volts, direct current. The solenoid is energized only during the squeezing operation. Pattern draw is made on the down stroke by gravity and the speed of the draw is regulated by an oil dashpot in combination with the long guide pressure spindle.

Roller Bearings Used on Pouring Device

A new pouring mechanism recently has been introduced by the Modern Pouring Device division of the Modern Equipment Co., Port Washington, Wis. The new apparatus is built especially for the accommodation of small ladles of 100 to 200 pounds capacity used in pouring bench molds. The machine is adapted to use with moving conveyors where considerable height of lift is required. The pouring mechanism is equipped with a gear and rack raising attachment which is operated in conjunction with a ratchet and brake. The raising and lowering operations are controlled by a hand wheel which is rotated in a clockwise direction to raise the apparatus and in the opposite direction for lowering.

Gearing is mounted on ball and roller bearings and is enclosed in a steel housing. The rack is made of steel and is equipped at the upper end with a guide mounted on antifriction bearings. Equipment includes a sheet iron shield for protection to the operator, a ladle lock for holding the ladle erect during transportation to the pouring floor and a bail and shank especially adapted to conveyor pouring. An adjustable hanger frame fits the machine to various head room heights. The hanger is mounted on a roller bearing, adjustable wheel-



Raising and Lowering Are Controlled by a Hand Wheel

base trolley. The trolley frame is made of malleable iron. A feature of the trolley is that it can be set with a large wheel base for operation on straight track or with the smaller wheel base when operated on small radius curves. The accompanying illustration shows one of the new type mechanisms.

Lift Truck Operates Hydraulically

A lift truck which operates on the hydraulic principle, recently has been placed on the market by the Lyon Iron Works, Greene, N. Y. It has a 6000-pound capacity with a 3-inch vertical lift on a 3½-inch

The Truck Has a 6000-pound Capacity

stroke. The truck is made in two models, one with a platform 17 inches wide and from 30 to 42 inches long and the other with a 26½-inch platform from 42 to 60 inches long. On the former model, the lift and the wheel size correspond. In the latter, 7-inch wheels raise or lower the truck 7 inches, 8-inch wheels act through 9 inches and 10-inch wheels through 11 inches.

It is claimed that the truck lifts and is controlled easily. It may be operated by either long or short strokes of the handle. A lever located under the handle, as shown in the accompanying illustration, remains in the position illustrated when the load is raised. By pulling the lever upward toward the handle the load may be lowered quickly or slowly depending upon the pressure exerted. The machine has a turning radius of 360 degrees and the lever may be operated from any angle.

Change Office Locations

Shepard Niles Crane & Hoist Corp., 360 North Schuyler avenue, Montour Falls, N. Y., has changed the locations of its Pittsburgh and Cleveland sales offices. The Pittsburgh office has been moved to rooms 1524 and 1525, Grant building with Roy M. Hurst in charge as district manager. The Cleveland offices have been changed to 1433 East Twelfth street and Harry A. Baugh has been appointed district manager. Frank J. Kinney will be associated with Mr. Hurst in the Pittsburgh office.

Trade Trends in Tabloid

NUMEROUS encouraging signs have appeared upon the industrial horizon and in general, business prognosticators are agreed that American business is staging a comeback. The first quarter of the year witnessed an economic readjustment which it is believed will constitute the foundation for the slow but nevertheless sure improvement to follow.

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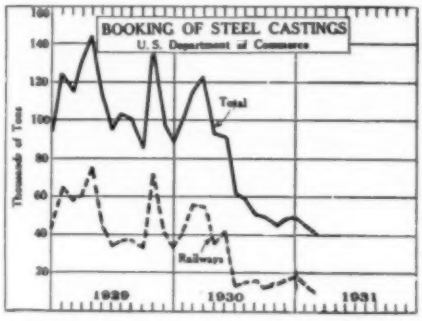
The encouraging situation also is apparent in the foundry industry. Automobile foundries, and especially the malleable shops have received heavier orders. The railway car market has



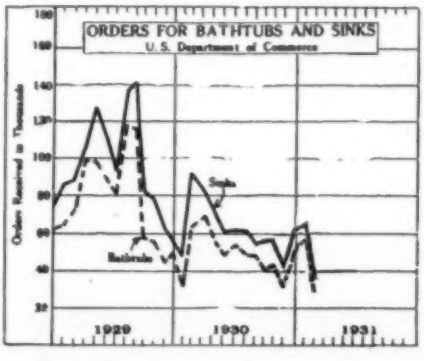
improved slightly and a better demand for machine tools has developed.

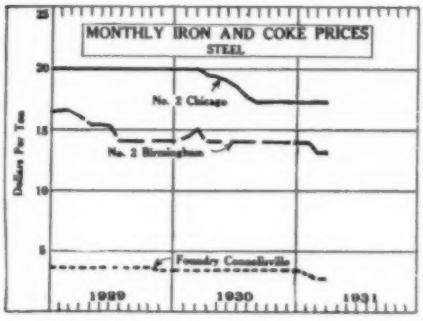
—T—T—

Of special interest is the recent report of the Foundry Equipment Manufacturers' association. The index of gross orders for March was the highest since February, 1930, with a total of 174.4 compared with 54.71 in February, 65.3 in January and 164.1 in March, 1930. Index of shipments increased from 55.36 in February to 72.9 in March and index of unfilled orders on April 1 was 314.6, a gain of 221.1 over the previous month.

—T—T—

Automobile production continues to expand slightly. March production was approximately 280,000 cars and trucks compared with 229,768 units in February and 178,347 in January. While it is believed that an exceptionally pronounced decline will not follow, various factors, such as the rumor that Ford will close for a 60 day





period early in the summer, indicate that present production probably will not be maintained.

—T—T—

Unfilled orders for brass and bronze ingots and billets of members of the Nonferrous Ingot Metal institute, totaled 23,132 tons on April 1, compared with 24,652 tons on March 1. Deliveries of ingots and billets in March totaled 4621 tons against 5067 tons in the previous month.

—T—T—

Freight car buying got off to a better start in March with a total of 2249 units purchased, contrasted with practically negligible awards during the preceding two months.

—T—T—

In the Pittsburgh district, foundry operations are holding at about the same rate that has prevailed for the past 30 to 60 days. Activity is rather spotty, with the average production continuing under 50 per cent. Most steel mill machinery builders are running full and roll foundries are slightly busier than earlier in the year. Ingot mold business also is moderately heavier.

RAW MATERIAL PRICES
April 21, 1931

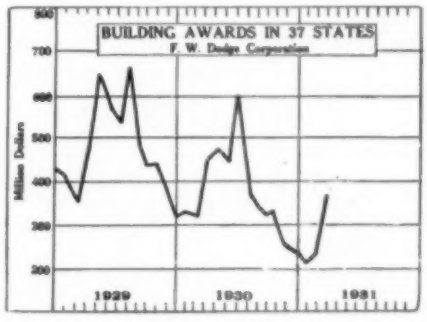
Iron	
No. 2 foundry, Valley	$17.00
No. 2 Southern, Birmingham	12.00 to 13.00
No. 2 foundry, Chicago	17.50
No. 2 foundry, Buffalo	17.50
Basic, Valley	17.50
Basic, Buffalo	17.00
Malleable, Chicago	17.50
Malleable, Buffalo	18.00
Coke	
Connellsville beehive coke	$3.25 to 4.75
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.50
Scrap	
Heavy melting steel, Valley	$11.25 to 11.75
Heavy melting steel, Pitts.	12.00 to 12.50
Heavy melting steel, Chicago	9.50 to 10.00
Stove plate, Buffalo	8.75 to 9.00
Stove plate, Chicago	7.50 to 8.00
No. 1 cast, New York	8.00 to 8.50
No. 1 cast, Chicago	8.75 to 9.25
No. 1 cast, Philadelphia	13.00
No. 1 cast, Pittsburgh	12.00 to 12.50
No. 1 cast, Birmingham	11.50 to 12.00
Car wheels, iron, Pittsburgh	13.00 to 13.50
Car wheels, iron, Chicago	9.25 to 9.75
Railroad malleable, Chicago	11.25 to 11.75
Agricultural mal., Chicago	10.00 to 10.50
Malleable, Buffalo	11.50 to 12.00
Nonferrous Metals	
	Cents per pound
Casting copper, refinery	9.50
Straits tin	24.62½
Aluminum, No. 12, producers	22.00
Aluminum, No. 12, remelt	10.50
Lead, New York	4.50
Antimony, New York	6.75 to 6.87½
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.65

—T—T—

Revenue freight car loading declined for the week ended April 4 for the second consecutive week, according to the American Railway association. The total for the week was 728,511, representing a decline of 11,568 cars.

—T—T—

Building awards for March constituted another bright spot, with a gain of 57 per cent over the previous month. Awards in the 37 states east of



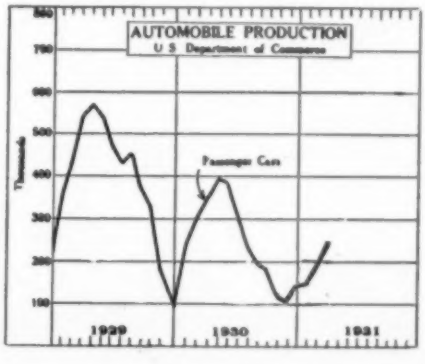
the Rocky Mountains, according to the F. W. Dodge Corp., totaled $370,406,300 in March compared with $235,405,100 in February and $459,119,000 in March, 1930.

—T—T—

While gains have been made among the automotive castings shops in the Chicago district, these have been offset by the closing down of some farm equipment foundries and a lack of activity in plants making railway equipment. Improvement has been noted in operations of aluminum and brass foundries.

—T—T—

According to the Gray Iron institute, Cleveland, production of member foundries was 55.3 per cent of normal in February, compared with 52.1 per cent in January. New business totaled 52.2 per cent in February compared with 51.4 per cent in the preceding month. Unfilled orders totaled 38.8 per cent of normal.



What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Shenango-Penn Mold Co., Sharpsville, Pa., has resumed operations.

Mal-Gra Castings Co., Lancaster Heights, Middletown, O., is reported to be operating at 100 per cent capacity.

Johnson City Foundry & Machine Co., Johnson City, Tenn., recently was damaged slightly by fire.

Davis Brass & Aluminum Foundry, 20 North Second street, Tippecanoe City, O., has discontinued business.

Clark's Iron & Brass Foundry, 79 West Forty-fourth street, Bayonne, N. J., recently resumed operations after being shut down since August, 1930.

Wedlake Aluminum Co., 1616 Willow street, Hoboken, N. J., has succeeded Wedlake & Lamson Co. D. C. Wedlake is proprietor.

Canada Metal Co. Ltd., Toronto, Ont., has been organized to take over the National Lead Co. of Canada Ltd., 721 Eastern avenue, Toronto.

National Foundries Ltd., Pont Rouge, Que., now is operating the plant formerly known as the Supreme Foundry Ltd.

Kenton Foundry Co., 116 Willis street, Portland, Oreg., now is manufacturing brass, aluminum and gray iron castings.

Seattle Stove Works, 3420 Thirteenth street, southwest, Seattle, is specializing in the manufacture of gray iron castings.

Stout Mfg. Co., Menomonie Falls, Wis., recently was purchased by Herman Krause and the name has been changed to the Menomonie Falls Mfg. Company.

Hock & Volk Brass Foundry, Baltimore, in care of G. S. Hock, is building a foundry for the production of brass, bronze and aluminum castings.

Somerset Foundry & Machine Co., Somerset, Pa., has been formed by the merger of the Somerset Garage & Machine Co., J. Roy Adams Co., and the Somerset Foundry & Machine Works.

Brighton Foundry Co., 3306 South Artesian avenue, Chicago, subsidiary of Paul Dickinson Inc., 3346 South Artesian avenue, Chicago, now is manufacturing gray iron castings.

Massey-Harris Co., Inc., Toronto, Ont., will concentrate the production of gray iron and malleable iron castings at its Batavia, N. Y., plant. Foundry facilities will be expanded. William S. Milne is general superintendent.

Tips Engine Works and Heierman Industries, both of Austin, Tex., have been merged into Heierman-Tips, 300 Crockett street, Austin, Tex. W. L. Heierman is president of the new company.

O. Chalifoux & Fils Ltd., St. Hyacinthe, Que., now is operating the plant formerly occupied by F. X. Bertrand. The new company manufactures gray iron castings and operates a machine shop and pattern shop.

Advance Castings Co., St. Louis, Mich., will move its activities to Owosso, Mich., and will occupy a section of the plant formerly operated by the Owosso Foundry Co. John Spousta is president of the Advance company.

Routson Brass Foundry, 2100 South Main street, Elkhart, Ind., is operating a pattern shop and is specializing in the manufacture of brass, aluminum and nickel silver castings for band instruments.

Mahan Foundry Co., Miami Chapel road and Baltimore & Ohio railroad, Dayton, O., has changed its name to the Edgemont Castings Co. The following men were elected officers of the new company: Henry Brown, president; Harvey Hines, vice president, and Roy Adams, secretary.

Fire seriously damaged the interior of the 4-story building occupied by the R. M. Eddy Foundry Co., 372 West Grand avenue, Chicago, on April 19. Loss is estimated at $150,000. The Eddy company produces gray iron and semisteel castings, largely for printing press manufacture. The company was organized in 1865.

Springdale Foundry Co., Springdale, Pa., plans to erect a plant in that city. Construction will be started about May 1 and about 50 men will be employed when the plant is completed. George Chismark, Tarentum, Pa., is secretary-treasurer of the company. (Noted April 1.)

Machined Steel Castings Co., Alliance, O., soon will begin a $55,000 expansion program which will involve the construction of an addition to the core room, 25 x 30 feet, a storage building, 40 x 100 feet, modernization of the sand preparation equipment, installation of new molding machines and conveyors in the sand preparation system. W. E. Trump is general manager of the company.

New Trade Publications

FACING MOLDS—Mold parting and facing compounds are described in a recent bulletin issued by the Kelly Graphite Mills, Stockertown, Pa. Directions and results are outlined for a "shake on," a "slick on," a "spray on" and for a parting composition made by the company.

LOADER—A folder recently issued by the Link-Belt Co., Chicago, illustrates equipment adapted to loading bulk material into trucks or cars and in particular the 1931 model crawler loader made by the company. Details of construction and views of the machine in typical applications are shown.

RECORDING INSTRUMENTS — Westinghouse Electric & Mfg. Co., Newark, N. J., has issued a folder describing electric recording instruments of the direct-acting, circular chart type including voltmeters and ammeters. Applications, operation, and construction are outlined.

HIGHWAY CULVERTS — United States Pipe & Foundry Co., Burlington, N. J., has issued an illustrated bulletin describing highway culverts made from cast iron pipe. The advantages of the pipe in that use are outlined and illustrations of typical applications are shown.

ELECTRICAL EQUIPMENT — Recent bulletins from the General Electric Co., Schenectady, N. Y., are devoted to equipment made by the company as follows: Fractional-horsepower, direct current motors; electric thrustors; squirrel-cage induction motors; electric glue pots; resistor units; immersion heaters; and vertical induction motors.

SAFETY GARMENTS—A complete line of safety clothing designed for foundry or factory wear is described in an illustrated booklet from the Holcomb Safety Garment Co., 128 North Jefferson street, Chicago. Leggings, gloves, aprons, and complete heat and abrasion resisting outfits are among the protective clothing offered.

INGOTS—A recent folder from the Tottenville Copper Co., Inc., 609 West Twenty-ninth street, New York, carries information on the technical service offered by the company to foundries. The research staff maintained by the company for matters related to the conversion of nonferrous metals into sound castings, is described, and illustrations of the laboratory are given.

ELECTRICAL EQUIPMENT — Recent bulletins from the General Electric Co., Schenectady, N. Y. describe and illustrate apparatus made by the company in the following lines: Steel-panel switchboards; totally-enclosed, fan-cooled, induction motors; small synchronous condensers; electric brazing equipment; thermostats; solenoid-operated field switches; relays; and rectangular switchboard instruments.

THERMOCOUPLES—Two new thermocouples, one for molten brass and the other for molten aluminum, are described in an illustrated folder and a bulletin from the engineering development department of the Brown Instrument Co., Philadelphia. Constructional features and operation of the thermocouples are outlined. Illustrations are given of typical applications in nonferrous foundries. A cooling curve of molten aluminum is a part of the engineering data included.

INGOT BRASS — Advantages and methods of preparation of ingots made by the Ajax Metal Co., Philadelphia, Pa., are described in a booklet recently issued by the company. Tentative specifications of 15 standard alloys adopted by the American Society for Testing Materials, with the recommendation of the United States bureau of simplified practice, are published in the booklet and their advantages to producer and user emphasized. An appendix giving data on the physical properties of the standard alloys is included.